WAR DEPARTMENT

TECHNICAL MANUAL

ORDNANCE MAINTENANCE

GENERATING UNITS M5 AND M6

1 AUGUST 1943

FOR ORDNANCE PERSONNEL ONLY

TECHNICAL MANUAL No. 9-1616

WAR DEPARTMENT
Washington, 1 August 1943

ORDNANCE MAINTENANCE

GENERATING UNITS M5 AND M6

Prepared under the direction of the
Chief of Ordnance

CONTENTS

*This manual supersedes TM 9-1616, dated 1 March 1942; TB 1616-1, dated 25 August 1942; and TB 1616-2, dated 11 November 1942.

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Section I

INTRODUCTION AND SCOPE

1. SCOPE.

a. This manual is published for the information and guidance of ordnance maintenance personnel. It contains detailed instructions for inspection, disassembly, assembly, maintenance, and repair of the Generating Unit M5 (including differences between M5 and M6), supplementary to those in the Field Manuals and Technical Manuals prepared for the using arms. Additional descriptive matter and illustrations are included to aid in providing a complete working knowledge of the materiel.

2. DIFFERENCES IN MANUFACTURE.

a. These generating units have been assembled by different manufacturers who have used standard parts made by still other manufacturers. Working drawings have been furnished by the Ordnance Department. Similar parts will be found reasonably interchangeable regardless of where they are made. A metal plate is mounted on the instrument panel door of each unit, carrying the name of the manufacturer or prime contractor responsible for the construction of that particular unit. If required to make a record of this, be sure to copy the name exactly as it appears, because firm names are sometimes similar. For example, Units M5 have been made by the Hobart Manufacturing Company and by the Hobart Brothers Company, two entirely unrelated companies, both in Troy, Ohio.

3. DESCRIPTION AND CONSTRUCTION.

a. General. This unit is a self-contained power plant consisting of three main units: gasoline engine, power generator, and switchboard. These units are mounted on a welded steel frame, which also serves as a skid when the unit is moved. The unit is completely enclosed by a sheet metal housing. The radiator end of the unit is considered the front, and the main generator end, the rear. Right and left sides are determined from the rear, facing forward. Hinged hoods on the sides and a vertically hinged door on the rear of the housing give access to the engine, generator, and instrument panel. A sheet metal battery cover on the lower front part of the housing is easily removed for the purpose of servicing the battery (fig. 1). The canvas instruction book holder is on the inside of the instrument panel door

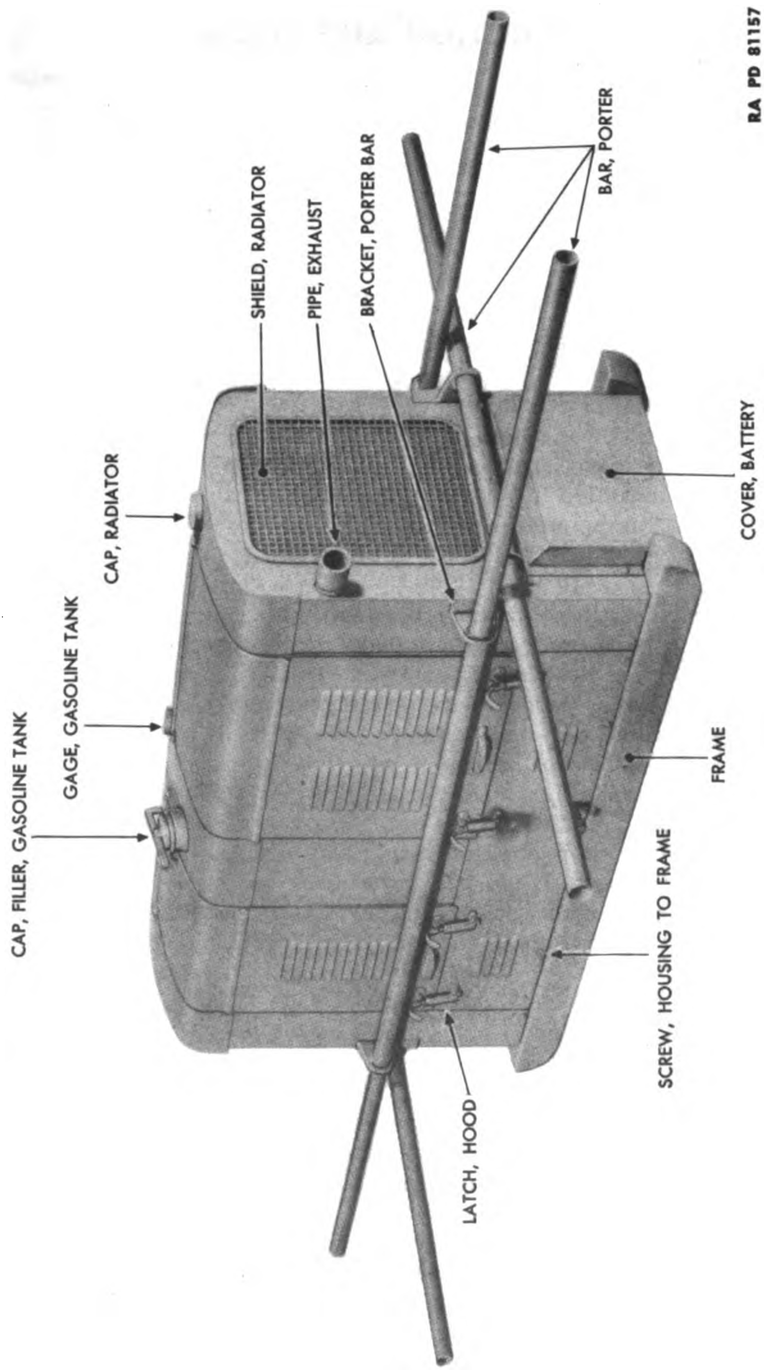


Figure 1 — Unit — Porter Bars in Place — Right Front View

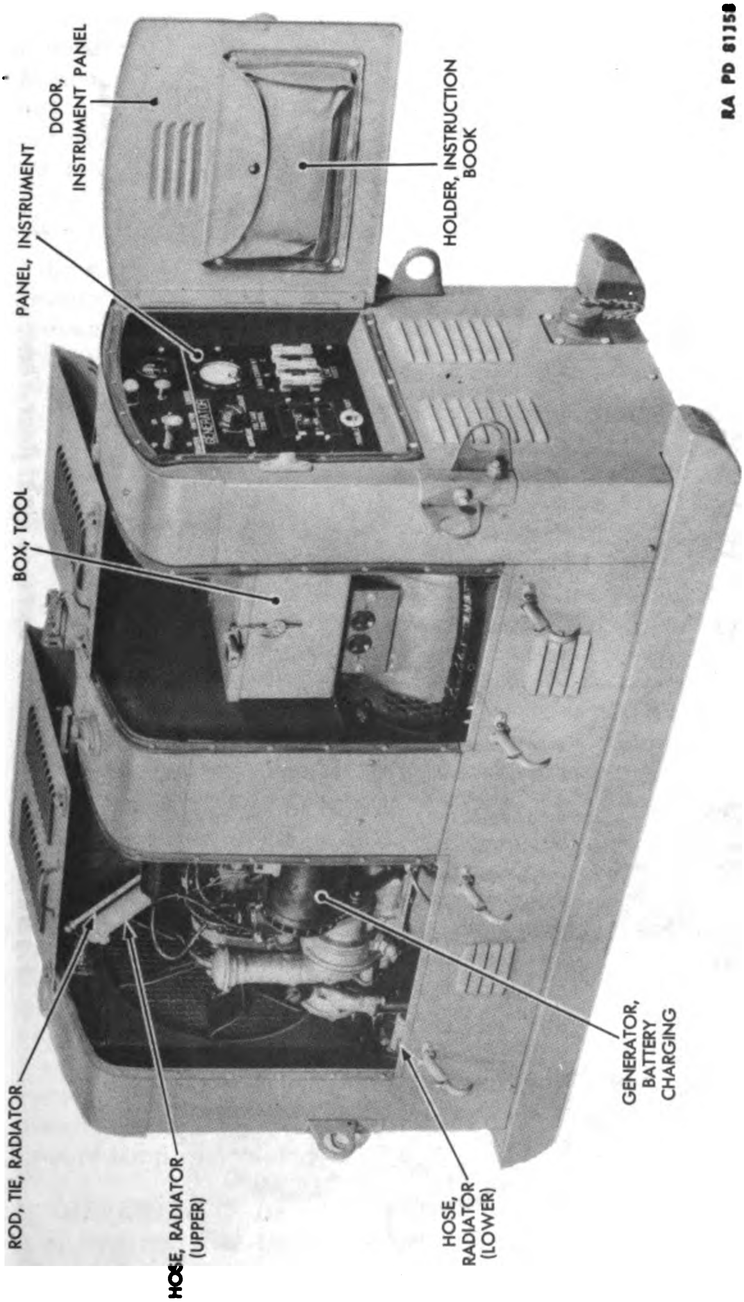


Figure 2 — Unit — Hoods Open — Left Rear View

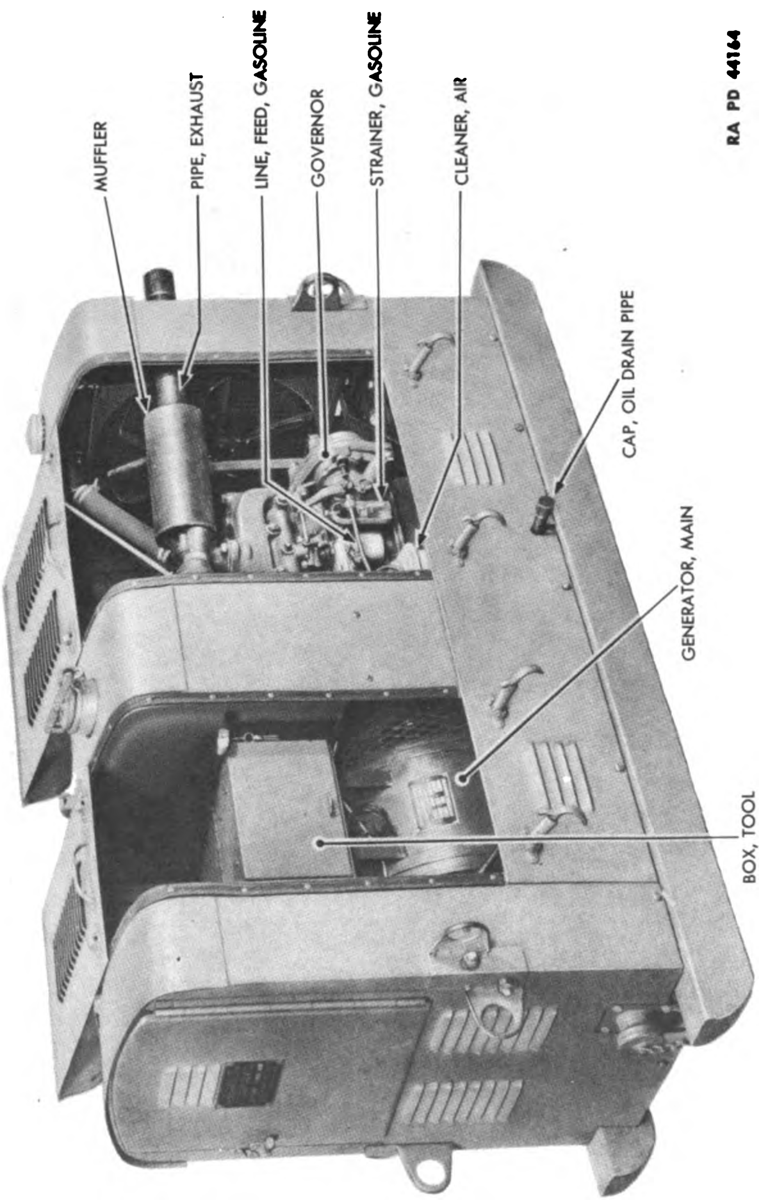


Figure 3 — Unit — Hoods Open — Right Rear View

(fig. 2). Four porter bar brackets are attached to the sides and ends of the unit. By inserting porter bars in the brackets six or eight men can carry the unit to any desired location (fig. 1). The gasoline tank is mounted on the inside of the housing, and the gasoline tank filler cap on the outer, right-hand side. The gasoline tank gage is on the left-hand side of the gasoline tank (fig. 1). A tool box, mounted on the generator, serves as a container for maintenance tools and spare parts (fig. 2). Spare cylinder head gaskets are carried under a steel plate bolted to the engine hood directly over the muffler (fig. 3).

b. Engine. The 4-cylinder, 4-cycle, 11-horsepower (N.A.C.C.) gasoline engine is directly connected to the main generator by a resilient coupling. It is equipped with an electric starting motor, battery charging generator (fig. 2), oil bath air cleaner, oil filter, and gasoline strainer. Engine speeds are controlled by a mechanical governor (fig. 3).

c. Main Generator. The main generator is an alternating-current generator of the revolving field type with separate excitation provided from a direct-current generator mounted in the same housing and on the same shaft. At 1,200 revolutions per minute, it delivers 3 KVA - 13.9 amperes at 125 volts 3-phase. Adjustments on the change-over panel governor provide either 50-cycle or 60-cycle current (fig. 2). The Unit M6, serial numbers 377 to 726 inclusive, delivers 2.5 KVA - 20 amperes at 125 volts single-phase, or 3 KVA - 13.9 amperes at 125 volts 3-phase. Units M6, serial numbers 1 to 266 and 367 to 376 inclusive, deliver 2.5 KVA - 20 amperes at 125 volts, single-phase only, but can be converted to deliver 3-phase current by making certain changes in wiring (par. 29).

d. Instrument Panel. The instrument panel (figs. 2 and 65) at the rear of the unit is reached by opening the instrument panel door. Engine controls and indicators which are on the upper part of the instrument panel, consist of an oil pressure gage, starter switch, ignition toggle switch, choke control, and battery charging generator ammeter. Generator controls and indicators, on the lower part of the instrument panel are a 0 - to 150-volt alternating-current voltmeter; a 32 -ohm field rheostat (voltage control); an alternating-current 0 - to 30-ampere ammeter; a 50-to-60-cycle frequency meter (cycle meter); a 2-pole main switch including circuit breaker, and three fuses. The dash lamp is at the top of the instrument panel and the trouble lamp socket at the bottom.

4. DIFFERENCES BETWEEN UNIT M5 AND UNIT M6.

a. Engine. The Units M5 and M6 are equipped with the same 11-horsepower engine. On the Unit M6, the engine is equipped with an auxiliary governor (fig. 7). This accessory eliminates "surge" which is especially objectionable on single-phase operation.

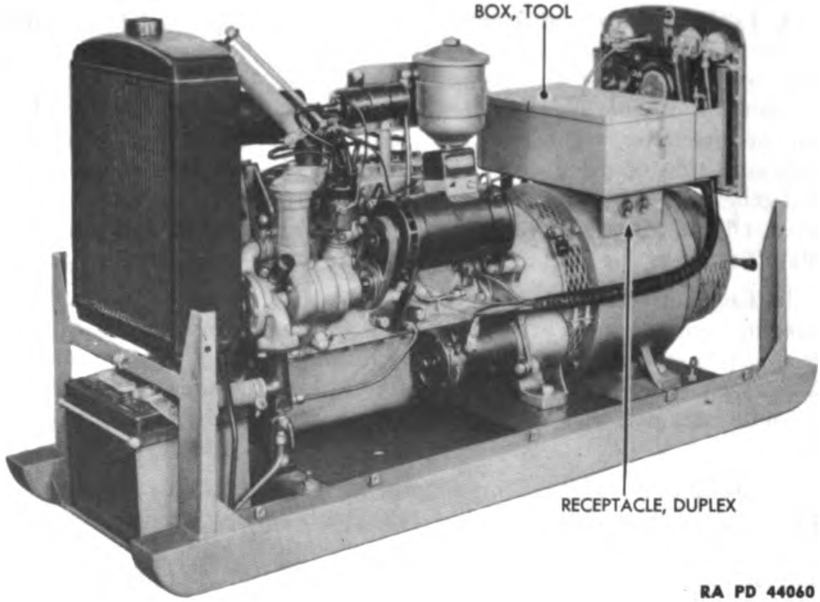


Figure 4 — Unit M5 — Housing Removed — Left Front View

b. **Main Generator.** Slightly larger pole pieces and laminations are provided in the main generator used on the Unit M6. Differences exist in the internal wiring of the generators (figs. 8, 9, and 10).

c. **Resistors, Capacitators, and Time Delay-relay.** Five resistors, four of fixed capacity and one of variable capacity, and three capacitators are located above the main generator on the Unit M6 (fig. 5). A time delay-relay is located to the right of the main generator on the Unit M6 (fig. 7). None of these assemblies appear on the Unit M5. All are needed to provide the single-phase conversion on the Unit M6.

d. **Outlet Receptacle.** All Units M5 have a 3-pole outlet receptacle (fig. 6). All Units M6 have a 19-pole outlet receptacle (fig. 7). Units M6, serial numbers 377 to 726, inclusive, also have a 3-pole receptacle located on the rear of the unit. The 19-pole outlet receptacles are used for single-phase current and the 3-pole outlet receptacles are used for 3-phase current.

e. **Duplex Receptacle.** Each generating unit is equipped with a duplex receptacle which serves as a means of securing current from the main generator to operate 110-volt lights and appliances. The receptacle is located under the tool box on the left-hand side of the Unit M5 and beneath the change-over panel on the right-hand side of the Unit M6.

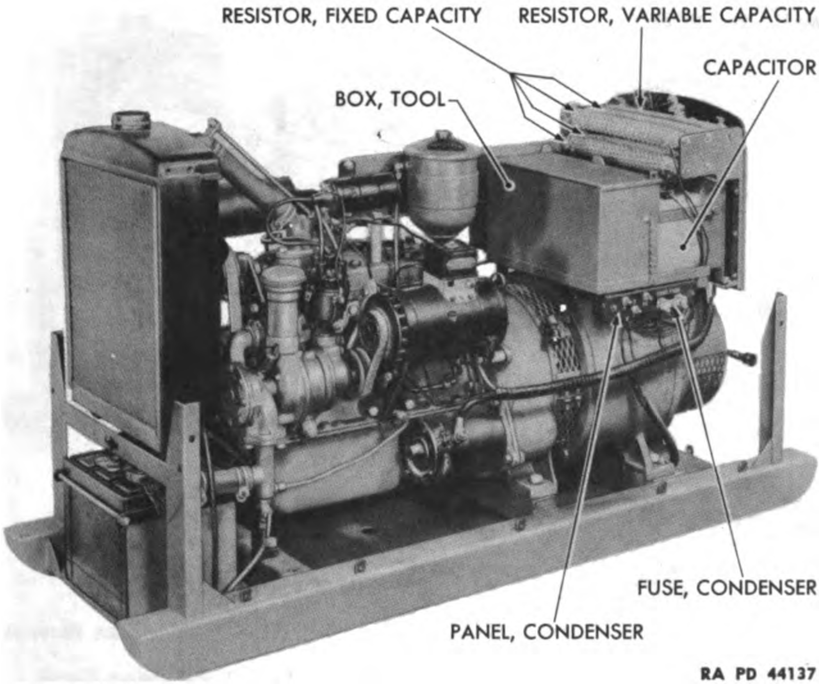


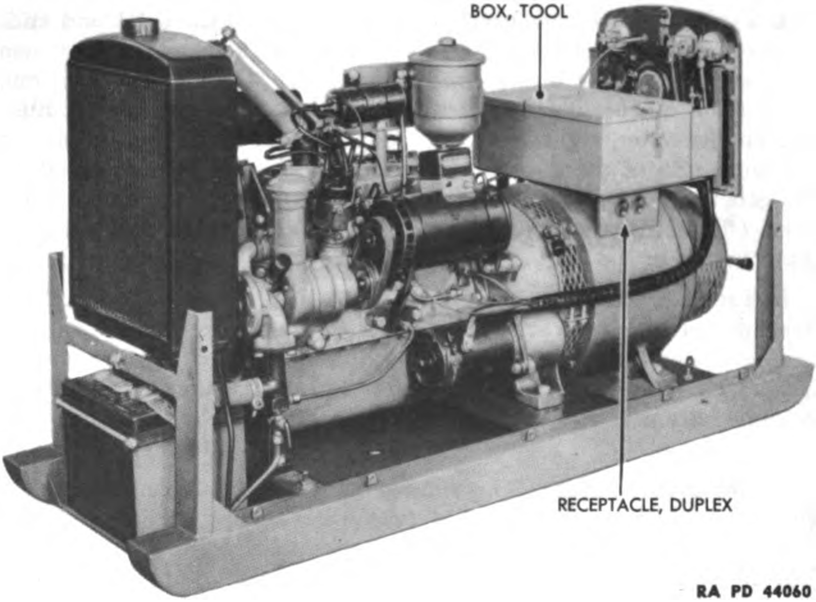
Figure 5 — Unit M6 — Housing Removed — Left Front View

f. Frequency Meter. A 10-reed frequency meter is used on the Unit M5 (fig. 6). Range of the meter is from 48 to 52, and from 58 to 62 cycles. On the Unit M6, a 5-reed frequency meter is used, having a range of from 58 to 62 cycles (fig. 7).

g. Tool Box. A rectangular, sheet metal tool box (fig. 4) is used on the Unit M5. An internal partition closes off a space for the change-over panel on the right-hand end. On the Unit M6, the tool box (fig. 5) is narrower and deeper. The compartment which houses the change-over panel is a separate box although it is welded to the same base.

h. Frame. Frames on the Units M5 and M6 are identical except that Units M6, serial numbers 377 to 726 inclusive, have an extra outlet receptacle bracket welded to the frame side member and sod pan to carry the extra 3-pole outlet receptacle (fig. 6).

i. Change-over Panel. Units M6, serial numbers 1 to 266 and 367 to 376 inclusive, have an 8- by 3¾-inch bakelite change-over panel with eight binding posts and three change-over bars. No adjustment is possible on this model. Units M6, serial numbers 377 to 726 inclusive, have an 8- by 5-inch bakelite change-over panel with



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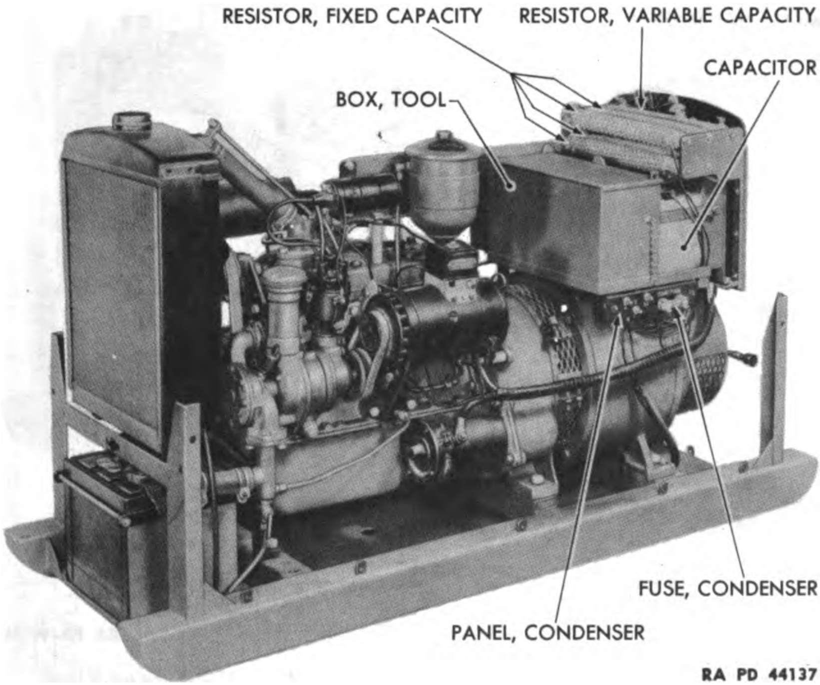

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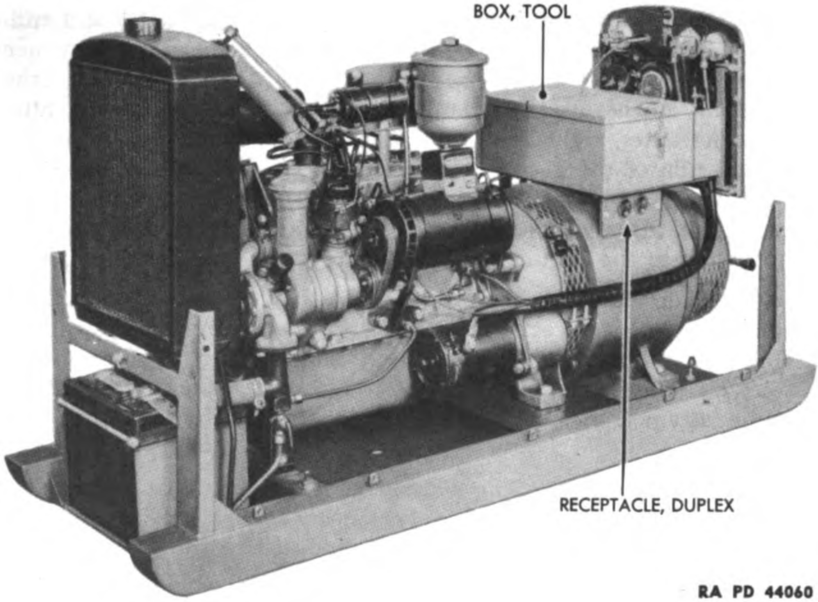

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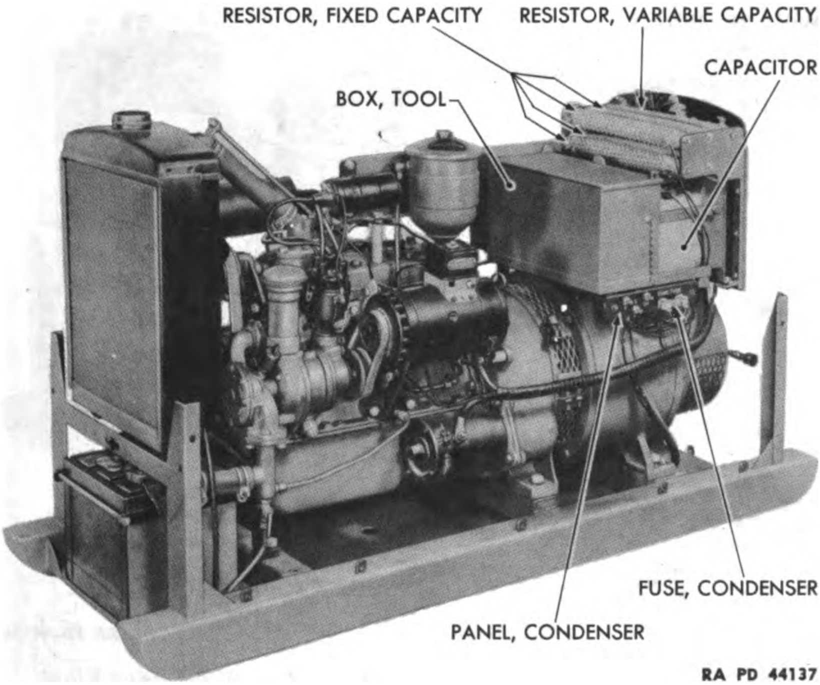
INTRODUCTION AND SCOPE



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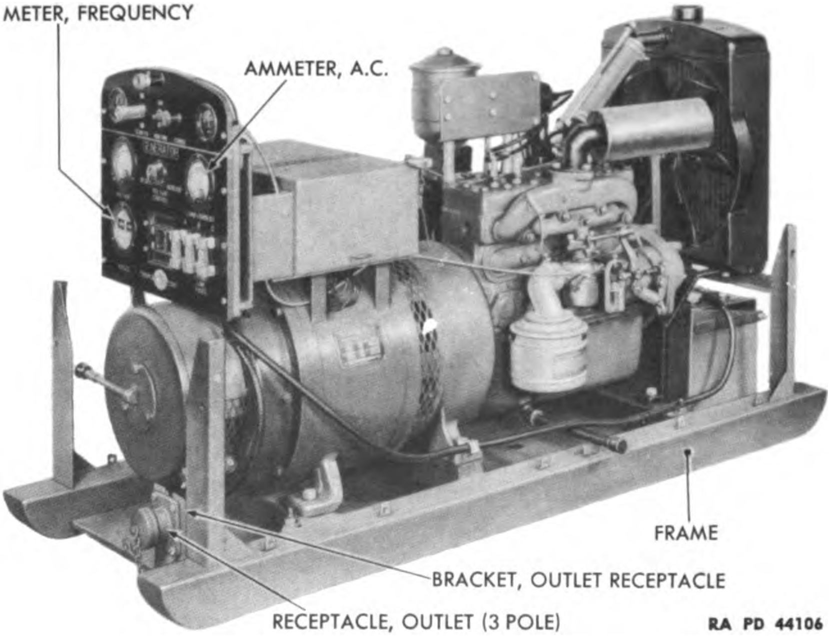

Figure 6 — Unit M5 — Housing Removed — Right Rear View

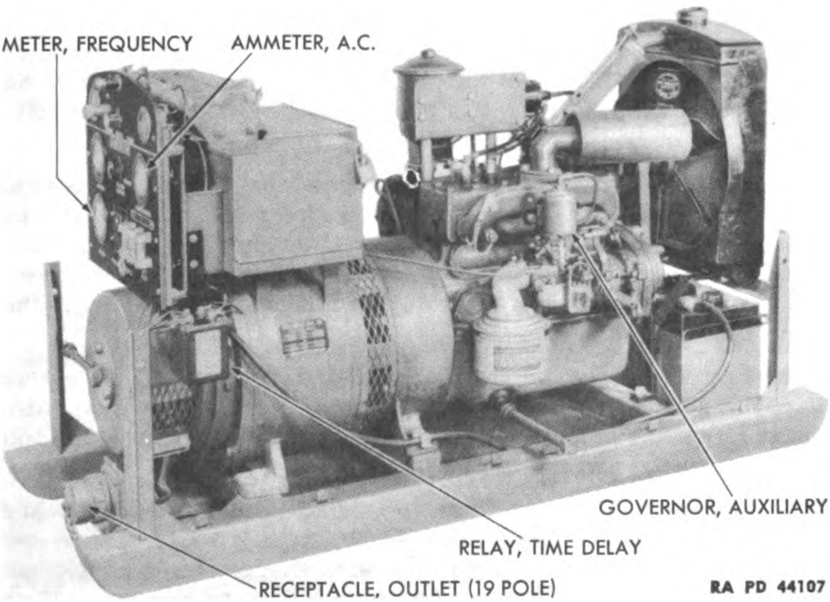

Figure 7— Unit M6 — Housing Removed — Right Rear View

INTRODUCTION AND SCOPE

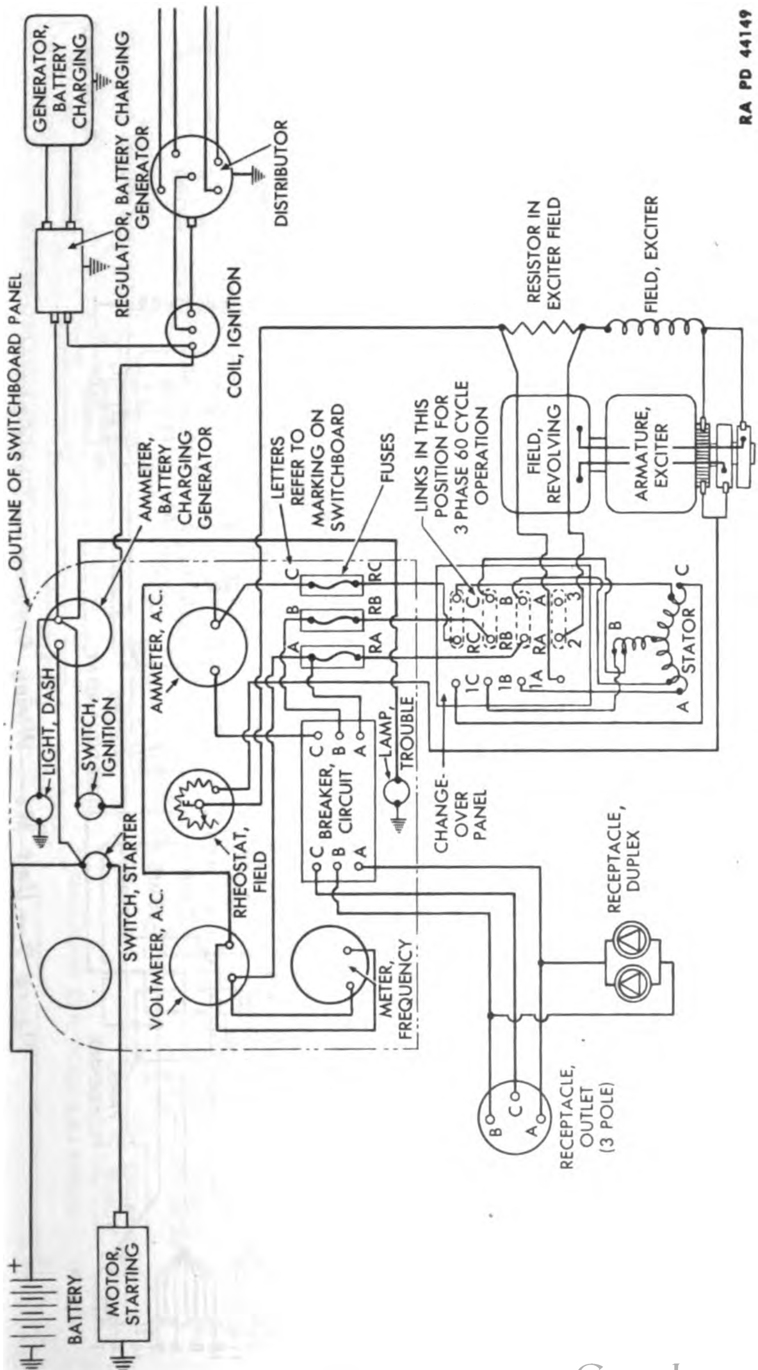

Figure 8 — Unit M5 — Wiring Diagram

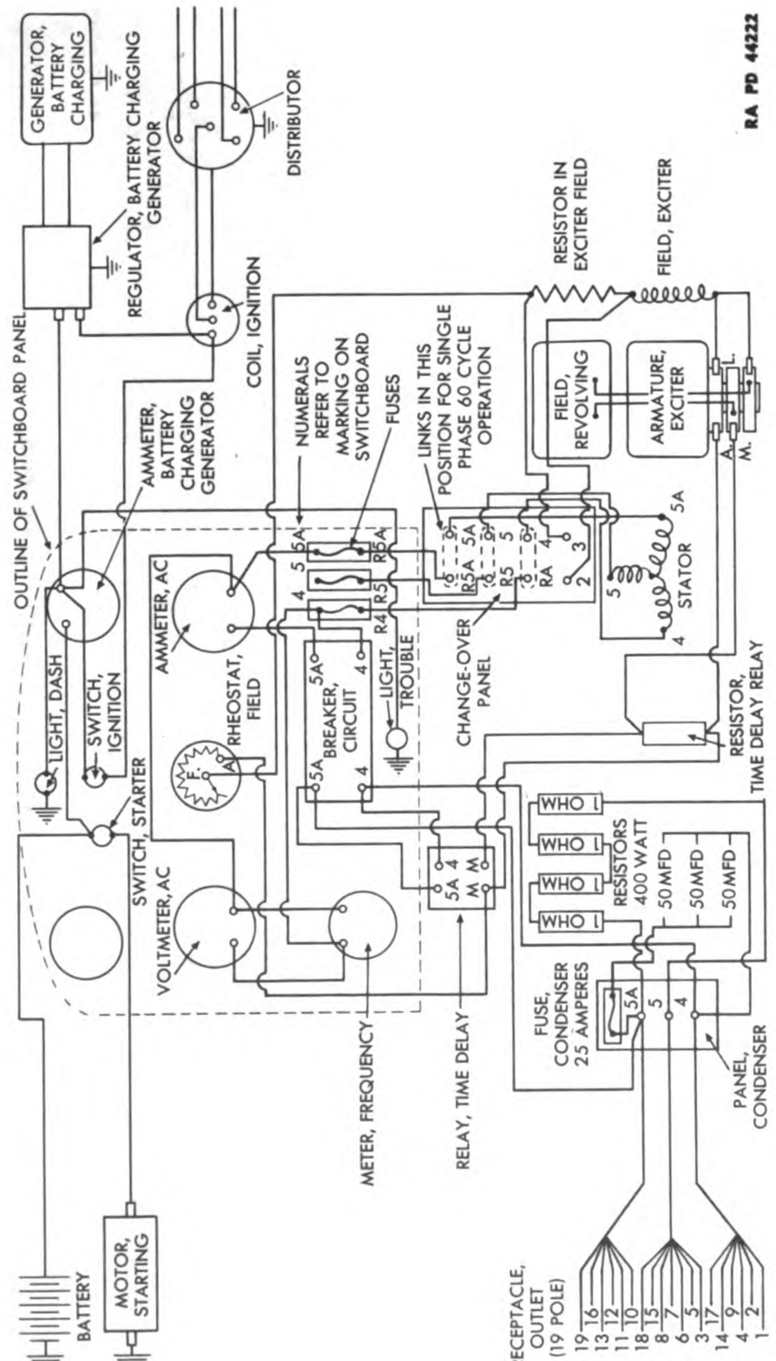

Figure 9 — Unit M6 — Wiring Diagram — Single-phase

INTRODUCTION AND SCOPE

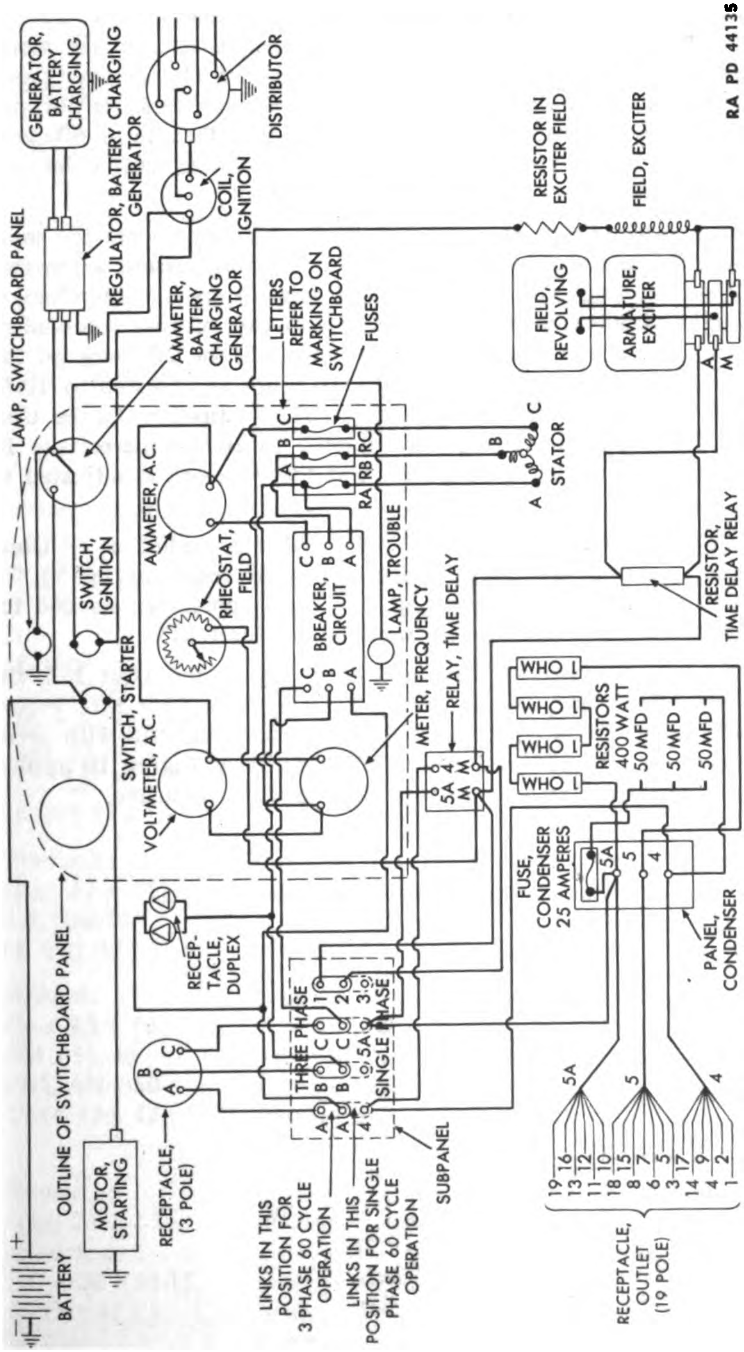

Figure 10 — Unit M6 — Wiring Diagram — Single and 3-phase

12 binding posts and four change-over bars. Its function is to enable the operator to adjust the unit for single-phase or 3-phase work. All Units M5 are equipped with an 8- by 5½-inch change-over panel equipped with 12 binding posts and 4 change-over bars. Its purpose is to enable the operator to adjust the unit for 50-cycle or 60-cycle work. On all models, the change-over panel is located within the tool box over the right-hand side of the generator.

j. **Alternating-Current Ammeter.** Although they appear the same and have the same part numbers, the alternating-current ammeters of the Unit M5 (fig. 6) and the Unit M6 (fig. 7) are not interchangeable. Slight differences in the adjustment of the internal mechanism are made during manufacture. On the Unit M5, the 20 mark on the scale is adjusted to 21.5 amperes; the 10 mark is adjusted to 10.75 amperes; and the 29 mark is adjusted to 31.20 amperes. On the Unit M6, the 20 mark on the scale is adjusted to 20.5 amperes; the 10 mark is adjusted to 10.25 amperes; and the 29 mark is adjusted to 29.75 amperes.

k. **Condenser Panel.** A condenser panel is provided on all Units M6. It is located below the left-hand end of the tool box (fig. 5). On the panel is a condenser fuse (fig. 5). These parts are needed for single-phase work. They are not used on the Unit M5.

l. **Wiring.** Differences exist in the wiring of the Unit M5, the single-phase Unit M6, and the single- and 3-phase Unit M6. Figure 8 applies to all Units M5. Figure 9 applies to Units M6 with serial numbers from 1 to 266 and 367 to 376, inclusive. Figure 10 applies to Units M6 with serial numbers 377 to 726, inclusive.

Section II

SERVICE MAINTENANCE

5. ALLOCATION OF MAINTENANCE DUTIES BY ECHELONS.

a. Definitions. Echelons and words as used in this list of maintenance allocations are defined as follows:

SECOND ECHELON:	Line organization regiments, battalions, companies, detachments, and separate companies (first and second echelons).
THIRD ECHELON:	Ordnance light maintenance companies, ordnance medium maintenance companies, ordnance divisional maintenance battalions, and post ordnance shops.
FOURTH ECHELON:	Ordnance heavy maintenance companies and service command shops.
FIFTH ECHELON:	Ordnance base regiments, ordnance bases, arsenals, and manufacturers' plants.
SERVICE: (Including preventive maintenance) (par. 23 a (1) and (2), AR 850-15 (6 Oct 42))	Consists of servicing, cleaning, lubricating, tightening bolts and nuts, and making external adjustments of subassemblies or assemblies and controls.
REPLACE: (par. 23 a (4), AR 850-15 (6 Oct 42))	Consists of removing the part, subassembly or assembly from the vehicles and replacing it with a new or reconditioned or rebuilt part, subassembly or assembly, whichever the case may be.
REPAIR: (par. 23 a (3) and (5), in part, AR 850-15 (6 Oct 42))	Consists of making repairs to, or replacement of the part, subassembly or assembly that can be accomplished without completely disassembling the subassembly or assemblies, and does not require heavy welding, or riveting, machining, fitting, and/or alining or balancing.
REBUILD: (par. 23 a (5), in part, and (6), AR 850-15 (6 Oct 42))	Consists of completely reconditioning and replacing in serviceable condition any unserviceable part, subassembly or assembly of the vehicle, including welding, riveting, machining, fitting, alining, balancing, assembling, and testing.

b. Maintenance Allocations.

	ECHELONS			
ENGINE	2nd	3rd	4th	5th
Camshaft—replace			x	
Connecting rod bearings—adjust		x		
Connecting rod bearings—replace				x
Connecting rods—replace			x	
Crankshaft—grinding, polishing, straightening				x
Crankshaft main bearings—replace			x	
Cylinder—boring, honing				x
Cylinder head—replace	x			
Engine—rebuild				x
Engine—replace		x		
Flywheel—replace		x		
Manifolds—replace	x			
Piston assembly—replace		x		
Piston pins—fitting		x		
Piston rings—fitting		x		
Pistons—fitting			x	
Timing gear cover—replace		x		
Tune-up	x			
Valve covers—replace	x			
Valve guides—replace			x	
Valve lifters and valve lifter guides—replace			x	
Valve springs—replace	x			
Valve tappets—adjustment	x			
Valves—clean carbon, light grinding		x		
Valves—replace	x			
Valves—reface and reseat		x		
COOLING SYSTEM				
Fan assembly—repair		x		
Fan assembly—replace	x			
Fan belt—adjust or replace	x			
Fan bushing or bearings—replace		x		
Hose or pipe—replace	x			
Radiator—clean and flush	x			
Radiator—repair		x		
Radiator—replace	x			
Thermostat—replace	x			
Water pump—rebuild				x
Water pump—repair		x		
Water pump—replace		x		
OILING SYSTEM				
Oil filter—replace	x			
Oil gage—replace	x			

SERVICE MAINTENANCE

	ECHELONS			
OILING SYSTEM (Cont'd)	2nd	3rd	4th	5th
Oil lines, external—clean or replace	x			
Oil lines, internal—flushing	x			
Oil lines, internal—repair or replace		x		
Oil pan—replace	x			
Oil pressure—adjustment	x			
Oil pump—repair or replace		x		
Oil strainer—clean or replace	x			
FUEL SYSTEM				
Air cleaner—clean or replace	x			
Carburetor—rebuild				x
Carburetor—repair		x		
Carburetor—replace	x			
Gasoline gage—repair		x		
Gasoline gage—replace	x			
Gasoline pipes and connections—repair or replace	x			
Gasoline tank—repair		x		
Governor—adjust	x			
Governor—rebuild				x
Governor—replace		x		
ELECTRICAL SYSTEM				
Ammeter—replace	x			
Battery—rebuild				x
Battery—repair		x		
Battery—replace, charge and service	x			
Battery cables—replace	x			
Breaker contacts—replace and adjust	x			
Distributor—repair		x		
Distributor—rebuild				x
Distributor—replace	x			
Generator—repair		x		
Generator—rebuild				x
Generator—replace	x			
Generator regulator—adjust and repair		x		
Generator regulator—rebuild				x
Generator regulator—replace	x			
Ignition coil, condenser, and spark plugs—replace	x			
Ignition harness—repair or replace wires		x		
Ignition harness assembly—replace	x			
Starting motor—rebuild				x
Starting motor—repair		x		
Starting motor—replace	x			
Starting motor spring (Bendix)—replace	x			
Switch, ignition or lighting and starting—repair		x		
Switch, ignition or lighting and starting—replace	x			

MAIN GENERATOR	ECHELONS 2nd	3rd	4th	5th
Bearing, ball, drive end—replace		x		
Bearing, ball, exciter end—replace		x		
Bracket assembly, exciter—repair or replace		x		
Bracket, coupling, bearing—repair or replace		x		
Brushes, commutator—replace	x			
Brushes, slip ring—replace	x			
Commutator—clean	x			
Commutator—turn and undercut		x		
Connections, electrical—tighten	x			
Fan, rotor—repair or replace		x		
Fittings, grease—repair or replace	x			
Flange, driving—repair or replace		x		
Housing, bell—replace		x		
Pole piece, exciter—repair			x	
Pole piece, exciter—replace			x	
Ring, brush—repair or replace		x		
Ring, slip—clean	x			
Ring, slip—true-up		x		
Rotor assembly—replace		x		
Springs, brush—adjust	x			
Springs, brush—replace		x		
Windings, field, exciter—repair		x		
Windings, field, exciter—replace		x		
Windings, rotor assembly—repair or replace		x		
Windings, stator assembly—repair or replace		x		
INSTRUMENT PANEL				
Ammeter, a-c—repair			x	
Ammeter, a-c—replace	x			
Breaker, circuit, a-c—repair				x
Breaker, circuit, a-c—replace	x			
Clips, fuse, a-c—replace	x			
Control, voltage, a-c—repair			x	
Control, voltage, a-c—replace	x			
Fuses, line, a-c—replace	x			
Meter, frequency—repair			x	
Meter, frequency—replace	x			
Terminal, wire—replace or tighten	x			
Voltmeter, a-c—repair		x		
Voltmeter, a-c—replace	x			
CHANGE-OVER PANEL				
Connections, electrical—clean and tighten	x			
Change-over bars—rearrange or replace	x			

SERVICE MAINTENANCE

WIRING	ECHELONS 2nd	3rd	4th	5th
Complete wiring—replace			x	
Single wire—replace	x			
MISCELLANEOUS				
Cleaning	x			
Frame assembly—repair or replace		x		
Housing assembly—repair or replace		x		
Lubrication	x			
Muffler and exhaust pipe—replace	x			
Painting	x			
Panel, instrument—repair			x	
Panel, instrument—replace		x		
Sheet metal—repair		x		

Section III

TECHNICAL INSPECTION

6. DESCRIPTION.

a. A technical inspection is a follow-up and a check on organization maintenance inspection and other maintenance functions. They determine whether the unit should be continued in service or withdrawn from operation for overhaul. These inspections are covered in paragraph 8.

7. INSPECTION RECORD.

a. A permanent record, listing any maintenance performed, should be kept of each inspection. A suitable inspection form, listing the points of inspection itemized in paragraph 8, can be prepared as a guide for maintenance personnel. Utility of the form will be increased if space is provided to record the date and remarks for each periodic inspection.

8. PRACTICAL APPLICATION.

a. Cooling System.

(1) Examine radiator and connections for signs of leakage, clogging or damage.

(2) Inspect fan for looseness, and fan belt for tension.

(3) Inspect water pump for cracks and leaks.

b. Battery Charging Generator and Regulator.

(1) Examine pulley for looseness.

(2) Check all electrical connections.

(3) Make sure all mounting and fastening screws are tight. Examine armature and brushes.

(4) Check voltage and current output of generator under full load.

(5) Inspect regulator contact points for burning and gap distance, and check tension of armature springs.

(6) Examine battery charging generator regulator case for cracks.

c. Ignition System.

(1) Inspect all wiring harness and terminals for damage, worn wiring, and loose connections.

(2) Examine and test ignition toggle switch.

(3) Check distributor for loose mounting or loose connections. Remove cap and inspect for cracks and carbon marks. Inspect breaker points and spring, high-tension rotor, and metal inserts in cap for pitting and burning. Turn cam to check for evidence of wear, looseness, and breakage of weight springs. Check distributor points for pitting and broken spring.

d. Starting Motor.

(1) Examine all connections and terminals.

(2) Inspect and test starting motor switch.

(3) Inspect commutator for carbon marks, and brushes for wear. Inspect brush springs for tension.

e. Engine.

(1) Check crankcase, block, head, and head gasket for cracks or leaks. See that all bolts are tight.

(2) Remove cover and examine valve push rods and springs. Check the valve clearance.

(3) Run engine and listen for slapping pistons, and knock in engine due to presence of carbon.

(4) Check oil pressure. Loose engine bearings are one cause of low oil pressure.

f. Fuel System.

(1) Examine gasoline tank for leaks or damage.

(2) Examine carburetor and air cleaner. Inspect connections to governor and choke rod. Check tightness of all gasoline line connections.

(3) Check gasoline gage.

g. Lubrication System.

(1) Check oil pressure at gage.

(2) Check oil line connections and brackets for tightness.

h. Main Generator.

(1) Check all connections from generator to control instruments.

(2) Start engine, put on full load, and check operation of generator.

(3) Inspect all brushes and brush holders.

(4) Check tightness of engine to generator coupling stud nuts.

(5) Check front and rear bearings for wear or looseness.

(6) Check generator to frame bolts and nuts for tightness.

i. Instrument Panel.

(1) Operate unit under full load and observe operation of all instruments.

(2) Check all connections to instruments on back of panel.

(3) Check field rheostat (voltage control) by turning in each direction and checking rise and fall of voltage on voltmeter.

(4) Operate alternating-current generator with an overload. Circuit breaker should open.

Section IV

FRAME AND HOUSING

9. FRAME, DESCRIPTION AND CONSTRUCTION.

a. The frame is of welded steel construction and consists of two side members, three cross members, sod pan, and four brackets. The side members, in addition to acting as the main part of the frame, act as skids for transportation purposes. The cross members hold the side members in place and provide motor and generator mountings. The brackets, welded at the four corners of the unit, serve as supporting brackets for the radiator and the porter bar brackets. Eleven tapped brackets are welded to the sides and rear of the frame, and serve as attaching members for the sheet metal hood. A 1-piece sheet metal sod pan, securely welded to the side members, protects the unit at the bottom.

10. FRAME SPECIFICATIONS.

Make	The Hobart Brothers Co.
Type	Welded construction
Material	Steel
Over-all length	53 in.
Width	20¼ in.
Distance from front of front brackets to rear of rear brackets	47 in.
Distance between centers of engine front mounting bracket holes	7¼ in.
Distance between centers of engine rear mounting bracket holes	12⅛ in.
Distance between centers of generator mounting holes	11⅛ in.

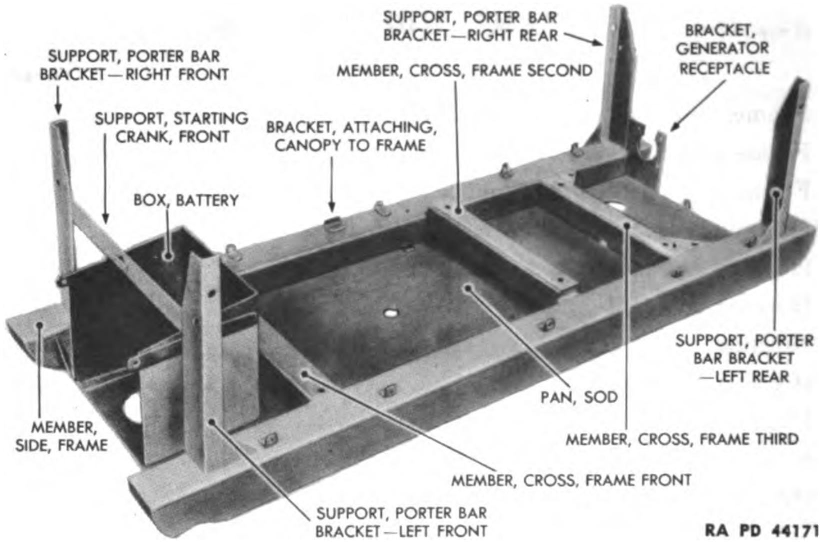

Figure 11 — Frame Assembly

Distance between centers of engine front and rear mounting holes . . . . 18⅝ in.

Distance between centers of engine rear mounting holes and main generator mounting holes . . . . 10⅞ in.

11. FRAME, INSPECTION AND REPAIR.

a. Equipment.

CHAIN (2)
JACK hydraulic (2)
TAPE, steel

b. Procedure.

(1) Visually inspect all welded joints. If any of the welded joints are broken, reweld.

(2) Check for cracked or bent cross members and supports. Weld minor cracks. Straighten bent cross members or supports (two hydraulic jacks and two chains).

12. HOUSING, DESCRIPTION AND CONSTRUCTION.

a. The entire unit is inclosed in a sheet metal housing. Two hoods provide access to the generator and to the engine. The hoods are hinged at the top and held in place by brackets at the ends of the hood hinge rod, and by latches at the bottom. A radiator shield on the front of the housing protects the radiator (fig. 1). On the rear is a

FRAME AND HOUSING

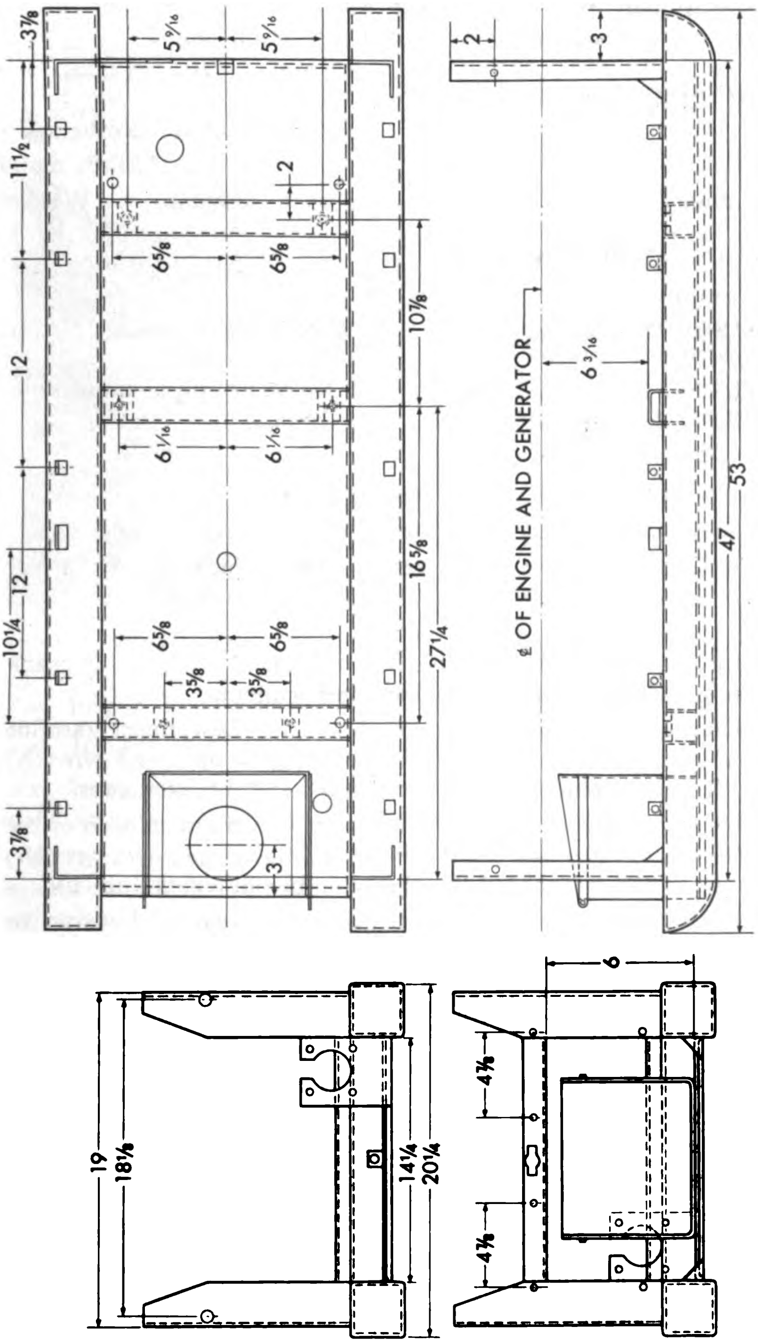

Figure 12 — Frame Checking Dimensions

hinged instrument panel door which acts as a protection for the instrument panel when the unit is not in operation (fig. 2).

13. HOUSING SPECIFICATIONS.

Make .... The Hobart Brothers Co.
Type .... Sheet metal
Construction .... Welded

14. HOUSING REMOVAL.

a. Equipment.

GASOLINE, container
SCREWDRIVER
WRENCH, open-end, 1/2-in.
WRENCH, open-end, 9/16-in.
WRENCH, open-end, 11/16-in. (2)
WRENCH, pipe, adjustable, 14-in.

b. Procedure.

(1) Remove radiator cap by hand (fig. 1).

(2) Remove exhaust pipe (adjustable pipe wrench) (fig. 1).

(3) Remove six screws and lock washers which secure battery cover to housing (screwdriver) (fig. 1). Lift battery cover from housing.

(4) Lift right-hand engine hood. Lift out funnel and starting crank from inside right-hand side of engine compartment.

(5) Close shut-off cock under gasoline tank. Disconnect gasoline line from gasoline strainer on carburetor (9/16-in. open-end wrench) (fig. 3). Drain gasoline from the tank into a suitable container.

(6) Remove nuts, lock washers, and bolts which attach each of the four porter bar brackets to frame assembly (9/16-in. open-end wrench) (11/16-in. open-end wrench). Lift off porter bar brackets (fig. 1).

(7) Remove screws which secure sides and rear of housing to frame assembly (screwdriver) (fig. 1).

(8) Remove screws and plain washers which secure the sheet metal apron (under the instrument panel) to the housing (screwdriver) (fig. 2).

(9) Remove dash lamp bulb guard and bulb.

(10) Lift housing assembly vertically (two men) until it is clear of radiator and instrument panel. Set housing on floor.

(11) Lift felt pads from top of radiator and top of main generator.

15. HOUSING INSPECTION.

a. Inspect all sheet metal for dents and exterior damage.

b. Inspect all hood and door webbing to see that it is not broken or damaged.

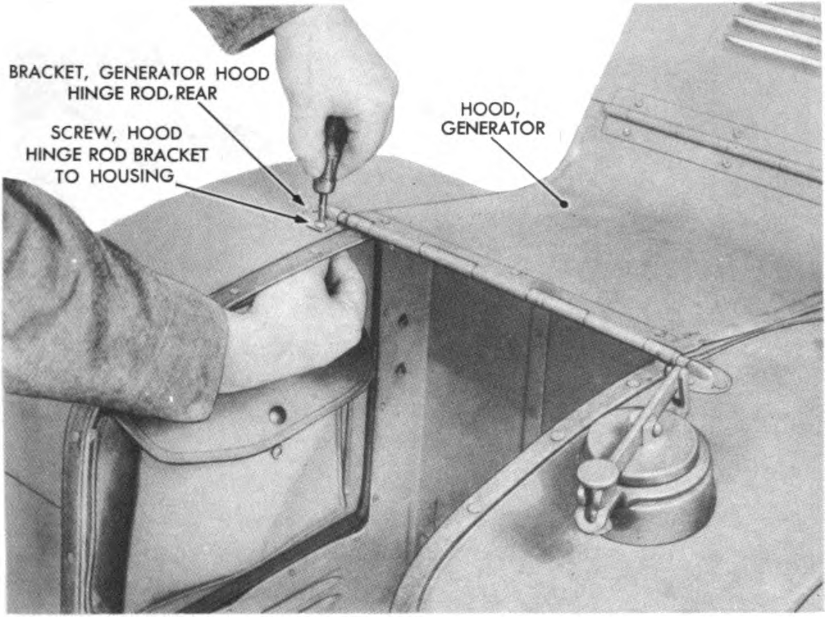

Figure 13 — Removing Canopy Generator Hood

c. Inspect hood latches for broken springs and looseness.

d. Inspect gasoline tank for leaks and rust particles.

e. Inspect all rivets which hold handles catches, webbing, hinges, and hinge rod brackets to be sure that all are tight.

f. Inspect gasoline tank shut-off cock and gasoline line for discoloration which indicates leakage.

16. HOUSING DISASSEMBLY.

a. Equipment.

SCREWDRIVER
WRENCH, open-end, ½-in.
WRENCH, socket-head set-screw, ⅛ in.

b. Procedure.

(1) REMOVE DOORS.

SCREWDRIVER

(a) Remove nuts, lock washers, and screws which secure generator hood hinge rod rear bracket to housing assembly (screwdriver) (fig. 13). Lift generator hood from housing.

(b) Remove nuts, lock washers, and screws which hold engine hood rear hinge rod bracket to housing assembly (screwdriver). Lift engine hood from housing assembly.

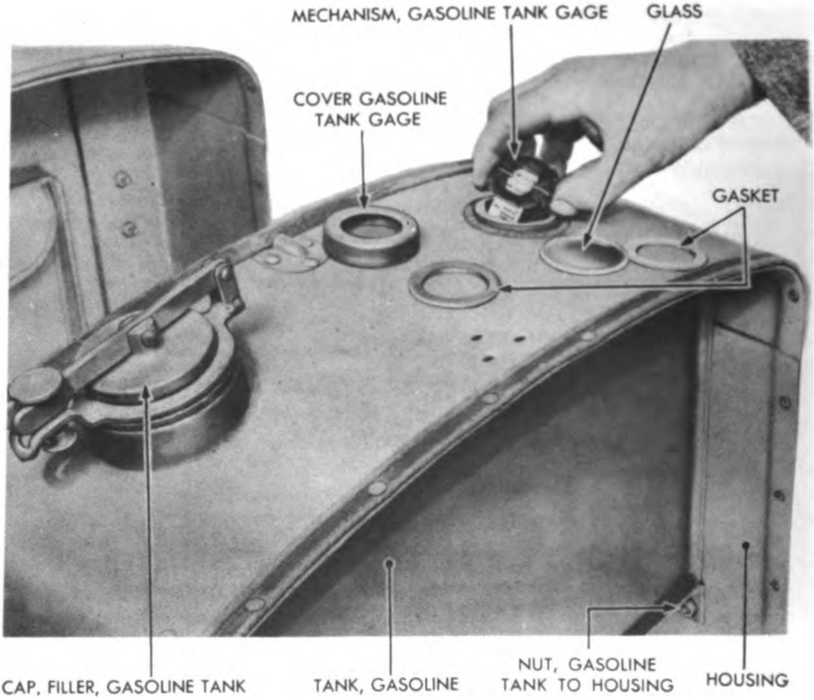

Figure 14 — Removing Gasoline Gage

(2) REMOVE GASOLINE GAGE.

(a) Unscrew gasoline tank gage cover by hand (fig. 14).

(b) Lift off the cover, two gaskets, and glass (fig. 14).

(c) Lift gasoline tank gage mechanism from gasoline tank (fig. 14).

(3) REMOVE GASOLINE TANK FILLER CAP ASSEMBLY.

WRENCH, socket-head setscrew, ⅛-in.

(a) Lift cap and loosen setscrews on inside cap (⅛-in. socket-head setscrew wrench) (fig. 15).

(b) Turn the gasoline tank filler cap assembly one-half turn and lift from tank (fig. 16).

(c) Remove the gasoline tank filler cap gasket (fig. 16).

(4) REMOVE GASOLINE TANK.

SCREWDRIVER   WRENCH, open-end, ½-in.

(a) Remove nuts, lock washers, and screws which attach gasoline tank to sides of housing (screwdriver) (fig. 14).

(b) Drop gasoline tank down and remove from housing assembly.

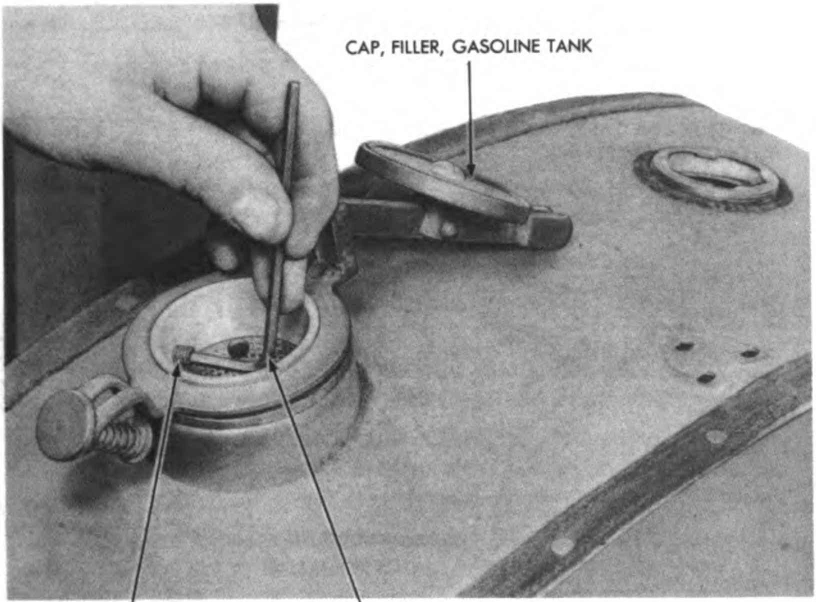

Figure 15 — Removing Gasoline Tank Filler Cap Assembly

(c) Remove the gasoline line from the gasoline shut-off cock, and the gasoline shut-off cock from gasoline tank (½-in. open-end wrench).

17. HOUSING, MAINTENANCE AND REPAIR.

a. Equipment.

FILE	SOLDERING EQUIPMENT
HAMMER	SOLVENT, dry-cleaning
PAINT	TOOL, sheet metal bumping
REMOVER, paint	WELDING EQUIPMENT

b. Procedure.

(1) If it is necessary to repaint the housing, remove all paint with REMOVER, paint and varnish and clean surfaces with SOLVENT, dry-cleaning. Bump out all dents in sheet metal (sheet metal bumping tool). In places hard to reach on the inside of sheet metal parts, fill dents with solder (soldering equipment). File solder flush with metal surface; clean and paint.

(2) Remove all worn or torn webbing, and replace with new, securely riveting it to housing (hammer).

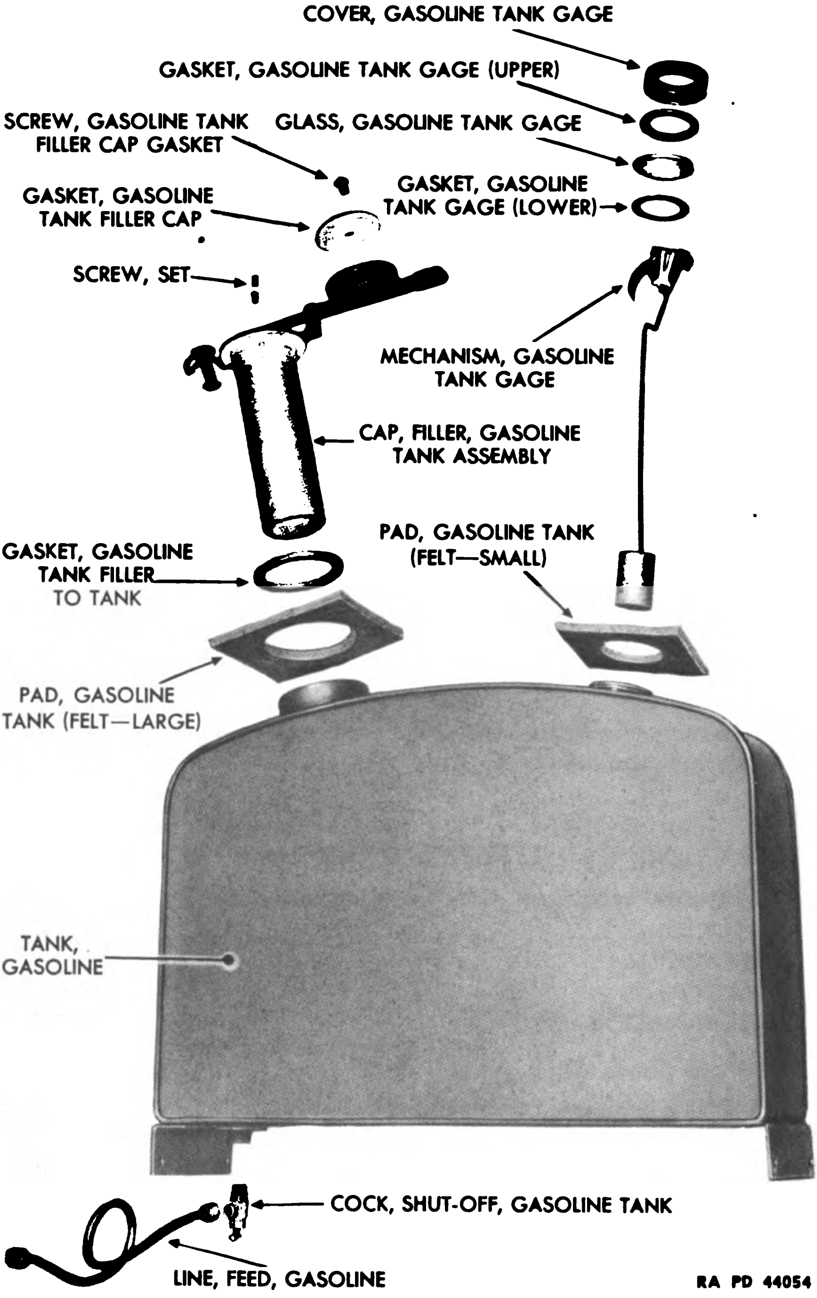

Figure 16 — Gasoline Tank Assembly — Exploded View

(3) Replace all broken hood and door catches, handles, hinges, etc. Rivet them securely in place.

(4) Weld all broken joints (welding equipment).

18. HOUSING ASSEMBLY.

a. Equipment.

SCREWDRIVER
WRENCH, open-end, 9/16-in.
WRENCH, socket-head setscrew, 1/8-in.

b. Procedure.

(1) Assemble gasoline tank shut-off cock to gasoline tank (9/16-in. open-end wrench).

(2) Place gasoline tank in position and secure in place with four bolts, lock washers, and nuts (screwdriver) (fig. 14).

(3) Place gasoline tank gage mechanism in position in tank. Install gasket, glass, and another gasket in gage cover, and screw cover to tank (fig. 16).

(4) Assemble gasoline tank filler cap and screen to gasoline tank, and lock in place with two setscrews (1/8-in. socket-head setscrew wrench) (fig. 15).

(5) Assemble the gasoline line to the shut-off cock (9/16-in. open-end wrench).

(6) Assemble generator hood to hinge rod front bracket, and secure the hinge rod rear bracket to hood with screws, lock washers, and nuts (screwdriver) (fig. 13).

(7) Assemble engine hood to hinge rod front bracket, and install hinge rod-rear bracket with screws, lock washers, and nuts (screwdriver) (fig. 13).

(8) Fasten hoods to housing by means of hood latches (fig. 1).

19. HOUSING INSTALLATION.

a. Equipment.

SCREWDRIVER
WRENCH, open-end, 9/16-in.
WRENCH, open-end, 11/16-in.
WRENCH, Stillson, 14-in.

b. Procedure.

(1) Install housing assembly on unit by lowering it straight down over the radiator and instrument panel (two men) (fig. 1).

(2) Replace dash lamp bulb and guard (fig. 2).

(3) Install sheet metal apron under switchboard panel with three screws and plain washers (screwdriver) (fig. 2).

(4) Attach bottom of housing to frame (screwdriver) (fig. 1).

(5) Attach four porter bar brackets, one to each end of housing ($\frac{9}{16}$- and $1\frac{1}{16}$-in. open-end wrenches).

(6) Connect gasoline line to gasoline strainer at the carburetor ($\frac{9}{16}$-in. open-end wrench) (fig. 3).

(7) Place funnel in position under engine hood and place starting crank in its position under engine.

(8) Assemble battery cover to front of housing (screwdriver) (fig. 1).

(9) Assemble exhaust pipe to muffler (Stillson wrench) (fig. 3).

Section V

MAIN GENERATOR AND EXCITER

20. DESCRIPTION AND CONSTRUCTION.

a. The main generator consists of two generators mounted on the same shaft in the same housing between one set of bearings. The smaller of the two generators is a direct-current stationary field type generator. Its function is to furnish excitation (direct current) for field windings of the other generator. The other generator is an alternating-current revolving field type generator. Its function is to deliver the electrical output of the unit.

b. On the Unit M5, the generator is a 3-phase, 3 KVA, alternating-current generator. It produces 60 cycles, 125 volts at 1,200 revolutions per minute or 50 cycles, 130 volts at 1,000 revolutions per minute.

c. On the Unit M6, serial numbers 377 to 726, the generator can be adjusted to deliver either a single- or 3-phase output. As a single-phase generator, it delivers 2.5 KVA, 20 amperes, 60 cycles, 125 volts at 1,200 revolutions per minute. As a 3-phase generator it delivers 3 KVA, 13.9 amperes, 60 cycles, 125 volts at 1,200 revolutions per minute. Units M6 bearing serial numbers 1 to 266, inclusive, and 367 to 376, inclusive, deliver only single-phase current.

d. The field system for the exciter is built in the exciter bearing bracket of the main generator (fig. 17).

e. Brush holders for exciter commutator and slip rings are of the radial box type. They are easily reached by removing brush cover immediately under instrument panel (fig. 17).

f. Two ball bearings support the armature shaft. Two screw type grease cups are provided for bearing lubrication.

g. A large fan is mounted on the end of the armature, toward the engine. It cools the generator by drawing air through the housing and from around all windings.

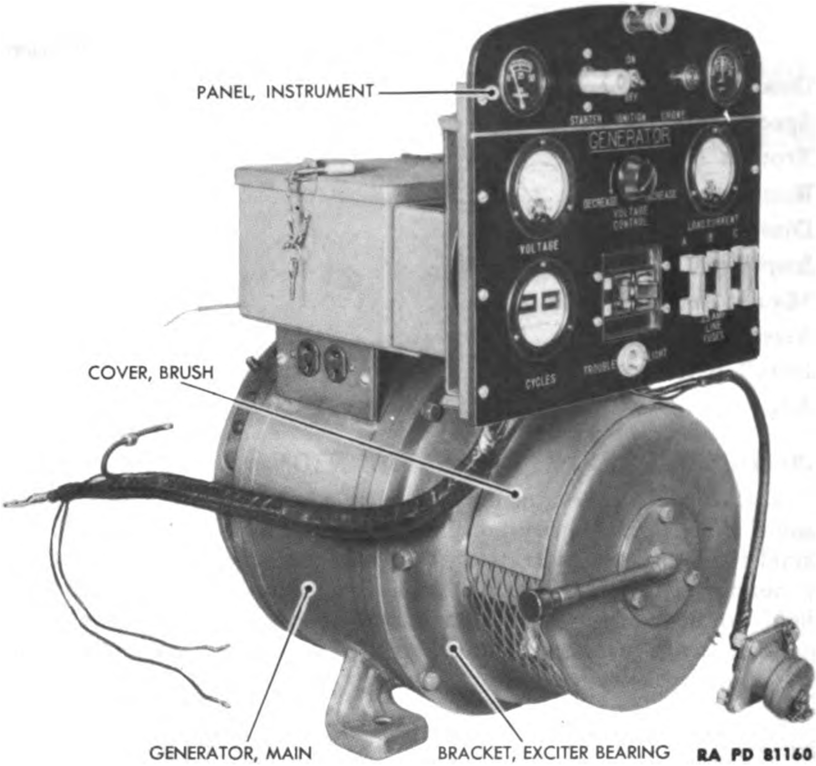

Figure 17 — Main Generator and Instrument Panel

21. SPECIFICATIONS.

a. Output (M5).

Volt	125 at 1,200 rpm 130 at 1,000 rpm
Phase	3
Cycle	60 at 1,200 rpm 50 at 1,000 rpm
KVA	3
Lagging power factor	0.8
Deviation limit of generator wave form	6 percent

b. Output (M6).

Volt	125 at 1,200 rpm
Phase	1 or 3
Cycle	60 at 1,200 rpm
KVA (single-phase)	2.5

MAIN GENERATOR AND EXCITER

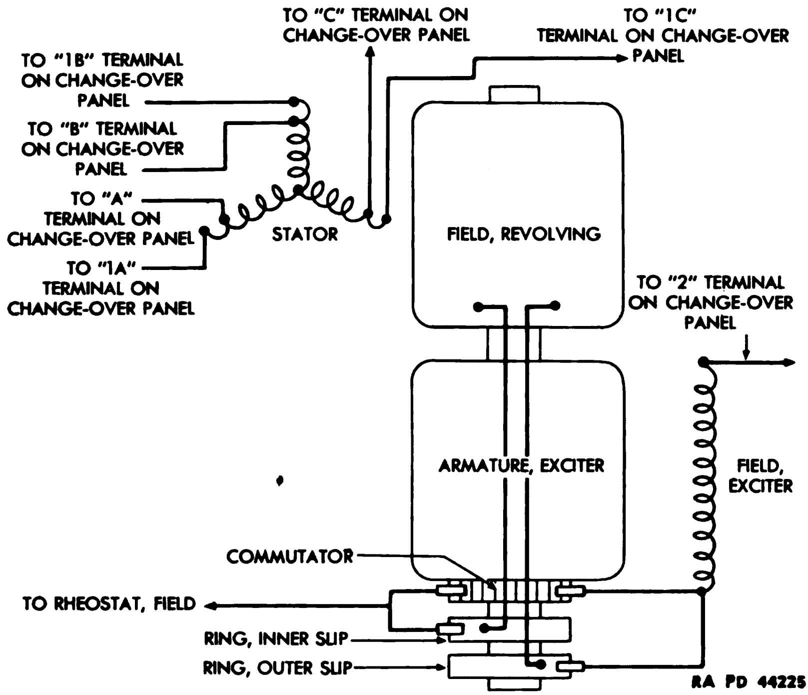

Figure 18 — Unit M5 — Diagram of Generator Wiring

KVA (three-phase) 3

c. Operation Limits.

Maximum deviation of generator wave form .... 6 percent
Maximum temperature rise, full load .... 40 C
Maximum temperature rise, 125 percent full load .... 55 C
Maximum voltage regulation at 0.8 lagging power factor . 16 percent

d. Construction.

Coils, type .... Form-wound
Coils, features .... Impregnated and baked
Rotor, type .... Balanced
Brush holders, type .... Adjustable spring tension
Brushes, material .... Carbon
Slip rings, material .... Copper
Commutator, material .... Copper
Field coils, number of (alternating-current) 6

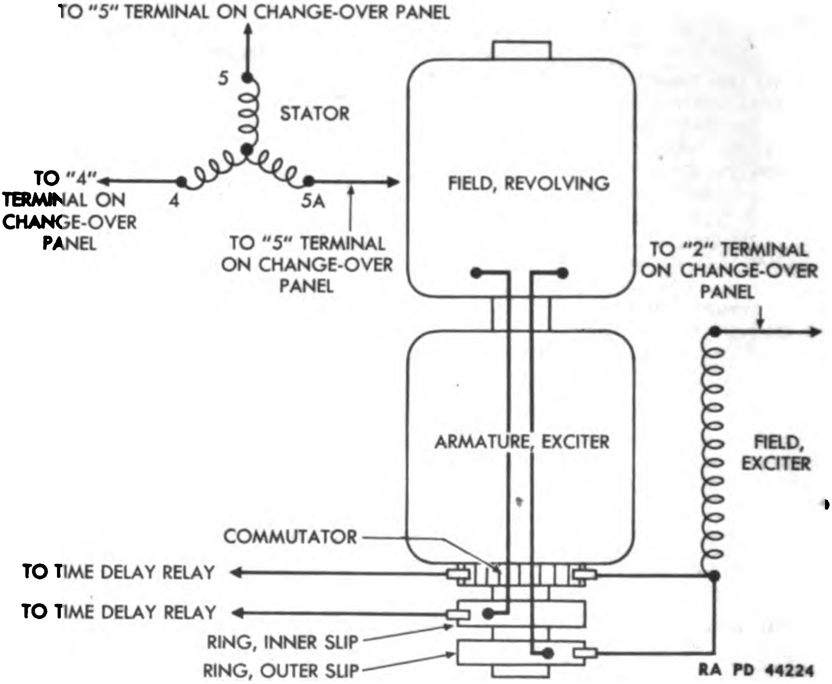

Figure 19 — Single-Phase Unit M6 — Diagram of Generator Wiring

Field coils, type (alternating current) .... Revolving
Field coil, features .... Removable and interchangeable
Bearings, number of 2
Bearings, make .... New Departure
Bearings, type .... "X"
Bearings, model WC-8507
Lubrication .... Screw type grease cup for each bearing

22. TROUBLE SHOOTING.

a. Equipment.

AMMETER	OHMMETERS
BATTERY	PROBE (2)
LAMP, test	VOLTMETER
LAMP, trouble, 110-volt	WIRE, electric

b. Procedure.

(1) GENERAL. Three things can go wrong with the coils and leads of a generator. These are an open circuit, short circuit, and a ground.

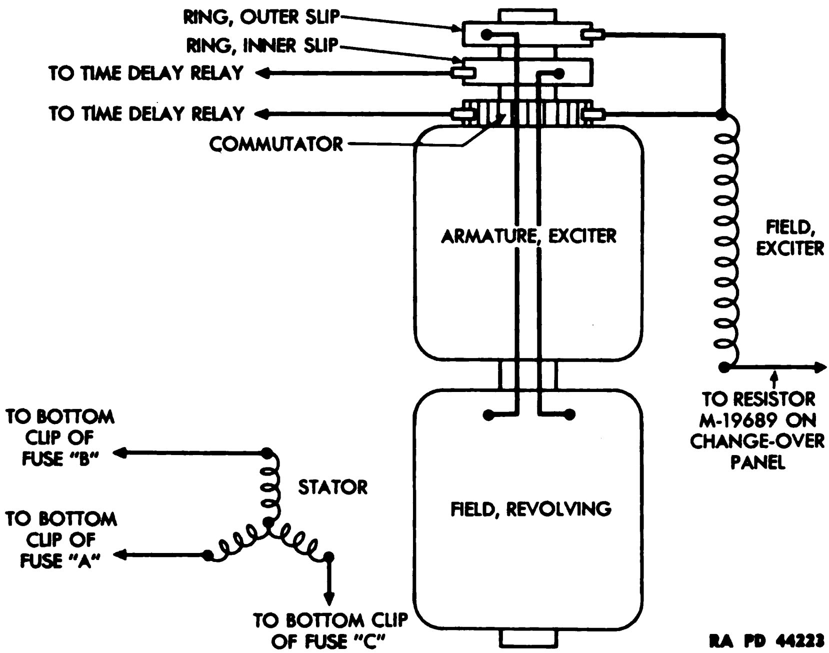

Figure 20 — Single and 3-Phase Unit M6 — Diagram of Generator Wiring

(a) Open Circuit. An open circuit is caused by a break in a wire or by an opening of a connection between two wires. This breaks the circuit because the current has no path to follow.

(b) Short Circuit. A short circuit is caused by lack of insulation on two touching wires. This enables the current to take a "short cut" instead of traversing the route it is supposed to follow.

(c) Ground. A ground is caused by lack of insulation on a wire or coil at point of contact with the framework of the generator. This allows the current to flow into the framework instead of following its proper course.

(2) CONSTRUCTION OF TEST LAMP.

BATTERY	WIRE, portable, lamp
PROBE (2)	

Construct a test lamp by connecting in series a probe, a battery, a lamp bulb, and another probe. Test operation of the test lamp by

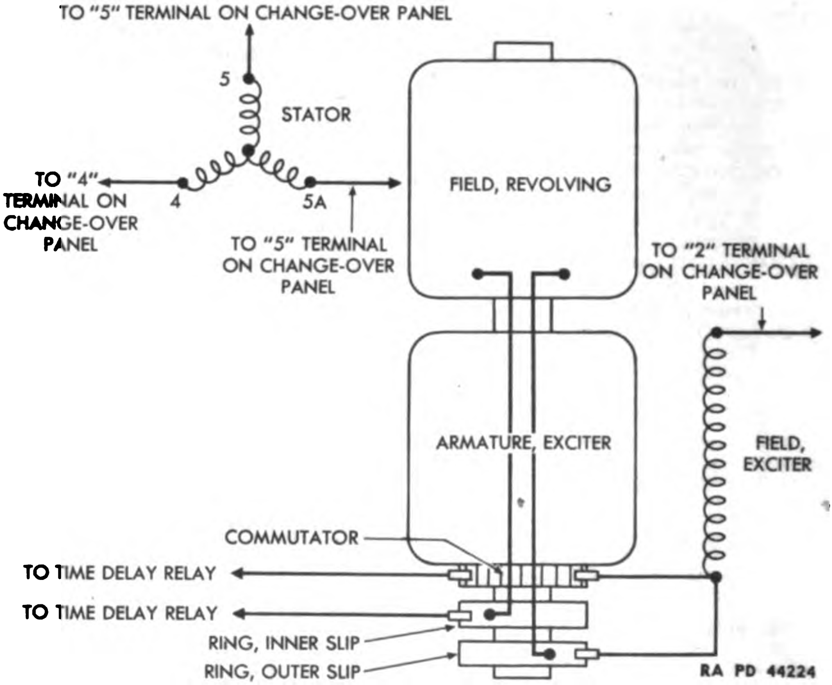

Figure 19 — Single-Phase Unit M6 — Diagram of Generator Wiring

Field coils, type (alternating current) .... Revolving
Field coil, features .... Removable and interchangeable
Bearings, number of 2
Bearings, make .... New Departure
Bearings, type .... "X"
Bearings, model WC-8507
Lubrication .... Screw type grease cup for each bearing

22. TROUBLE SHOOTING.

a. Equipment.

AMMETER	OHMMETERS
BATTERY	PROBE (2)
LAMP, test	VOLTMETER
LAMP, trouble, 110-volt	WIRE, electric

b. Procedure.

(1) GENERAL. Three things can go wrong with the coils and leads of a generator. These are an open circuit, short circuit, and a ground.

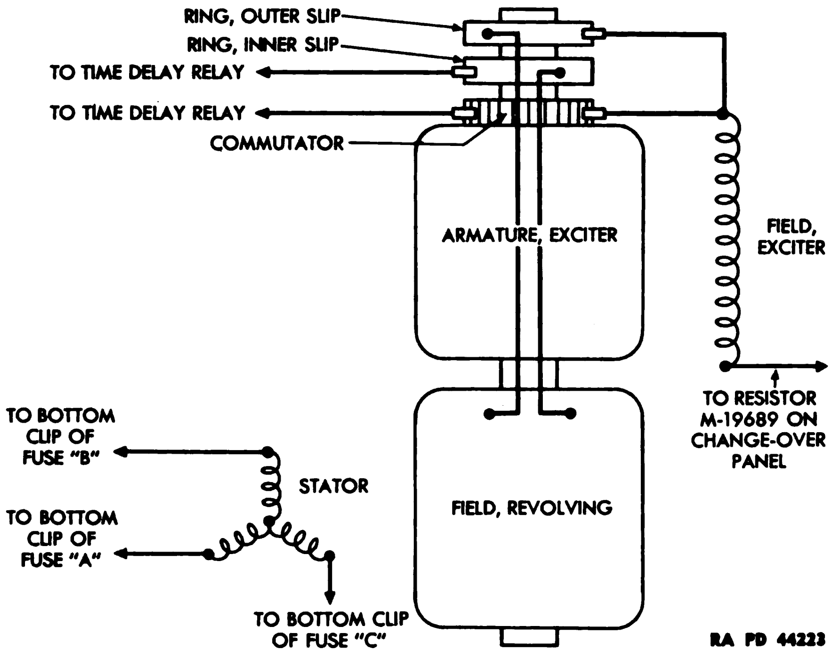

Figure 20 — Single and 3-Phase Unit M6 — Diagram of Generator Wiring

(a) Open Circuit. An open circuit is caused by a break in a wire or by an opening of a connection between two wires. This breaks the circuit because the current has no path to follow.

(b) Short Circuit. A short circuit is caused by lack of insulation on two touching wires. This enables the current to take a "short cut" instead of traversing the route it is supposed to follow.

(c) Ground. A ground is caused by lack of insulation on a wire or coil at point of contact with the framework of the generator. This allows the current to flow into the framework instead of following its proper course.

(2) Construction of Test Lamp.

BATTERY
PROBE (2)
WIRE, portable, lamp

Construct a test lamp by connecting in series a probe, a battery, a lamp bulb, and another probe. Test operation of the test lamp by

touching the points of the two probes together. The bulb should light.

(3) CHECKING FOR AN OPEN CIRCUIT.

LAMP, test

(a) Hold the point of one probe of a test lamp against the bare wire at one end of the coil or wire being tested.

(b) Place the point of the other probe against the bare wire at the other end of the coil or wire being tested.

(c) If the test lamp lights, a continuous circuit is indicated. If the test lamp fails to light, an open circuit exists in the coil or wire being tested.

(4) CHECKING FOR A SHORT CIRCUIT.

Location of short circuits is more difficult than finding open circuits. No specific directions which will apply to all cases can be given. In general, loss of generator output and presence of excessive heat indicate a short circuit.

(5) CHECKING FOR A GROUND.

LAMP, test

(a) Hold one probe of a test lamp against a bare lead to the coil or wire being tested.

(b) Touch other probe of test lamp against the frame of the generator.

(c) If the test lamp lights, a ground is present. If the lamp fails to light, absence of ground is indicated.

(6) LOCATING THE CAUSE OF MAIN GENERATOR FAILURE.

(a) Symptom—No Amperes at Rated Voltage Unit M5.

LAMP, test

1. Test fuses with test lamp. Replace fuse if lamp fails to light.

2. Turn on circuit breaker. Test for open circuit (test lamp) from top clip of fuse "A" on instrument panel to "A" socket of outlet receptacle (fig. 21). Repeat test from top clip of fuse "B" on instrument panel to "B" socket of receptacle. Repeat test from top clip of fuse "C" to "C" socket of receptacle. Repair or replace wiring of any circuit on which test lamp fails to light.

3. If steps *1* and *2* above reveal no open circuits, an open circuit is indicated in the wires or in the motor of the appliance receiving power from the unit.

(b) Single- and 3-phase Unit M6.

LAMP, test

If the unit is on 3-phase operation, the test is identical with step *(a)* above. If the unit is on single-phase operation, turn on the circuit breaker. Test for open circuit (test lamp) from top clip of fuse

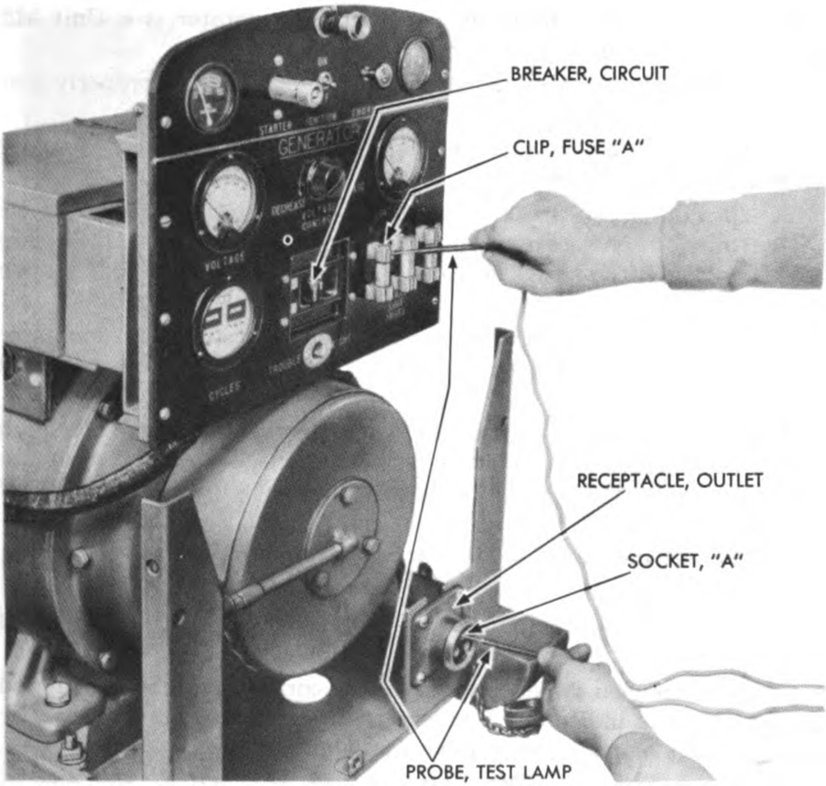

Figure 21 — Testing "A" Circuit for Open Circuit

"A" on instrument panel to sockets 1, 2, 4, 9, 14, and 17 of the 19-pole outlet receptacle. Repeat the test from top clip of fuse "C" to sockets 10, 11, 12, 13, 16, and 19 of the 19-pole outlet receptacle. Repair or replace wiring of any circuit on which test lamp fails to light.

(c) Single-phase Unit M6.

LAMP, test

Turn on the circuit breaker. Test for open circuit (test lamp) from top clip of fuse "4" to sockets 1, 2, 4, 9, 14, and 17 of the 19-pole outlet receptacle. Repeat the test from top clip of fuse "5A" to sockets 10, 11, 12, 13, 16, and 19 of the 19-pole outlet receptacle. Repair or replace wiring of any circuit on which test lamp fails to light.

(d) Symptom—Excessive Amperes at Rated Voltage.

AMMETER LAMP, test

NOTE: This condition arises only in 3-phase generators. There-

fore, the following steps apply whether the generator is a Unit M5 or a Unit M6 adjusted for 3-phase operation.

1. Inspect change-over panel (fig. 8) to be sure it is properly connected.

2. Test fuse "B" with a test lamp (step **b** (3) above). Replace fuse if test lamp fails to light.

3. Turn on circuit breaker. Test for open circuit (test lamp) from "B" terminal of change-over panel to bottom clip of fuse "B." Repeat test from top clip of fuse "B" to outlet receptacle socket "B." If open circuit is found, repair or replace faulty wiring or switch.

4. Test ammeter by disconnecting it and substituting an ammeter known to be good. Replace equipment ammeter if it does not read same as test ammeter.

5. If the trouble is not located and corrected in steps *1* through *4* above, an unbalanced load is probable. Check external wiring to unit for open circuit or poor connection in wire from socket "B" of outlet receptacle.

(e) Symptom—Insufficient Amperes at Rated Voltage.

LAMP, test

1. Inspect change-over panel to be sure it is properly connected (fig. 8).

2. If change-over panel connections are correct, an unbalanced load on generator is indicated. Test external wiring to unit for open or short circuits or poor connections (test lamp).

(f) No Amperes and No Voltage, Unit M5, and Single- and 3-phase Unit M6.

LAMP, test — PROBE (2)
LAMP, trouble, 110-volt

1. Start engine and turn on main switch.

2. Using a standard 110-volt trouble lamp, apply the probes at terminals "RA" and "RB" of change-over panel. Repeat test from terminals "RA" and "RC." Repeat test from terminals "RB" and "RC." Stop engine. To make this test on the single-phase Unit M6, apply the probes at "R4" and "R5" terminals of the change-over panel. Repeat test from terminals "R5" and "R5A." Stop engine.

3. If trouble lamp lights on all three tests, the generator is functioning. Proceed with steps *4* through *6* below. If trouble lamp fails to light on any two of the above tests, an open circuit in the stator or leads from stator is indicated. Disassemble generator and repair or replace stator. If trouble lamp fails to light on all three tests, proceed with steps *7* through *11* below.

4. This step applies to M5 and M6, single-phase only. For Unit M5 test for open circuit (test lamp) from change-over panel terminal

MAIN GENERATOR AND EXCITER

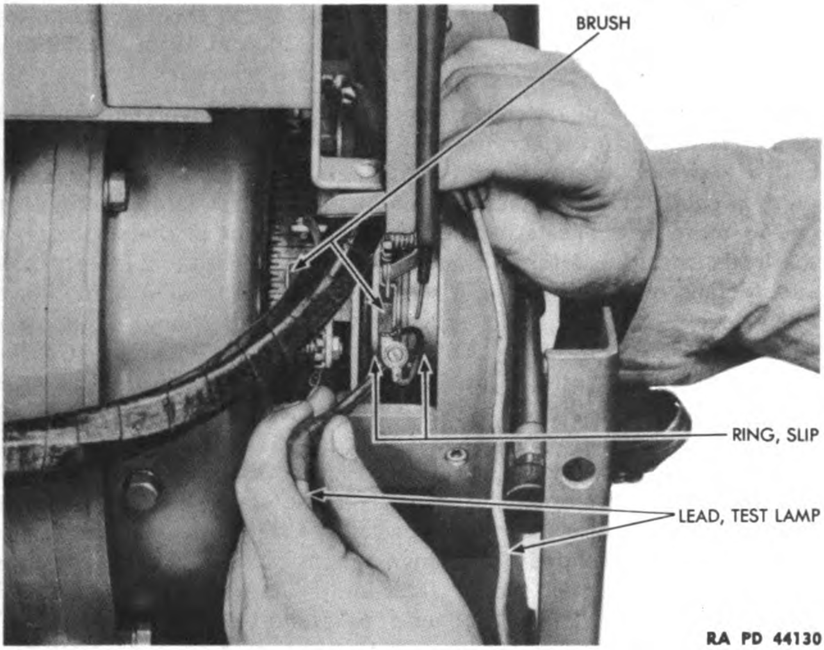

Figure 22 — Testing Revolving Field for Open Circuit

"RA" to bottom clip of fuse "A" on instrument panel. Repeat test from "RB" to bottom clip of fuse "B." Repeat test from "RC" to bottom clip of fuse "C." Repair or replace any wire having an open circuit. For Unit M6, test from terminal "RA" to bottom clip of fuse "4" on instrument panel. Repeat test from "RB" to bottom clip of fuse "5." Repeat test from "R5A" to bottom clip of fuse "5A." Repair or replace any fuse having an open circuit.

5. Test fuses with test lamp. Replace if burned out.

6. With circuit breaker on, check for open circuit from top clip of fuse "A" to socket "A" of outlet receptacle. Repeat test from "B" to "B" and from "C" to "C". Failure of test lamp to light indicates an open circuit or defective circuit breaker. Repair or replace defective parts. If the unit being tested is a single- and 3-phase Unit M6 on three-phase operation, the above steps apply. If the unit is on single-phase operation, turn on the circuit breaker. Test for an open circuit (test lamp) from top clip of fuse "A" to sockets 1, 2, 4, 9, 14, and 17 of the 19-pole outlet receptacle. Repeat the test from top clip of fuse "C" to sockets 10, 11, 12, 13, 16, and 19 of the 19-pole outlet receptacle. Repair or replace defective wiring. If the unit being tested is a single-phase Unit M6, turn on the circuit breaker. Test for open circuit (test lamp) from top clip of fuse "4" to sockets 1, 2, 4, 9, 14,

and 17 of the 19-pole outlet receptacle. Repeat the test from top clip of fuse "5A" to sockets 10, 11, 12, 13, 16, and 19 of the 19-pole outlet receptacle. Repair or replace defective wiring.

7. Remove the change-over bars on the change-over panel. If the generator is used to generate a 60-cycle current test for an open circuit between change-over panel terminals "A" and "B," "A" and "C," and "B" and "C" (test lamp). Failure of the test lamp to light on one or more of the tests indicates an open circuit in the stator or in the leads from the stator to change-over panel. Disassemble generator and replace or repair stator. If the generator is used to generate a 50-cycle current, make the above tests between change-over panel terminals "1A" and "1B," "1A" and "1C," and "1B and "1C." To test single- and 3-phase Unit M6, remove the fuses from the clips on the switchboard panel. Test for an open circuit between the bottom clips of fuses "A" and "B," "A" and "C," and "B" and "C" (test lamp). Failure of the lamp to light on any of the tests indicates an open circuit in the stator or in the leads from the stator to the fuse clips. Disassemble generator and repair or replace stator. To test the single-phase Unit M6, remove the change-over bars from the change-over panel. Test for an open circuit (test lamp) between the change-over panel terminals "4" and "5," "4" and "5A," and between "5" and "5A." Failure of the lamp to light on any test indicates an open circuit in the stator or in the leads from the stator. Disassemble generator, and repair or replace stator.

8. If step *7* above reveals no open circuit, remove the brush cover (fig. 22). Lift the four slip ring brushes (narrow) in their holders so that none make contact with either slip ring. Test for open circuit between the two slip rings (test lamp) (step **b** (3) above). If test lamp fails to light, an open circuit in the revolving field or leads is indicated. Disassemble generator, and repair or replace defective coil or lead.

9. When testing the Unit M5, if step *8* above reveals no open circuit, determine whether exciter is generating current by starting engine and applying a direct-current voltmeter between any two adjacent exciter brush holders (fig. 23). During this test, set field rheostat (voltage control) at maximum increase (i.e., turn voltage control knob clockwise as far as it will go). At least 56 volts should be indicated. If no voltage is shown, connect change-over bar on change-over panel between terminals "1" and "2." Repeat test for voltage. If this step produces voltage, replace resistor back of change-over panel between terminals "1" and "2." If correct voltage is present, check wire from commutator brush to slip ring brush for open circuit or poor connection. Check wire from top slip ring brush to field rheostat (voltage control) for open circuit or poor connection. Repair or replace defective wires. **NOTE**: Burned insulation on these two

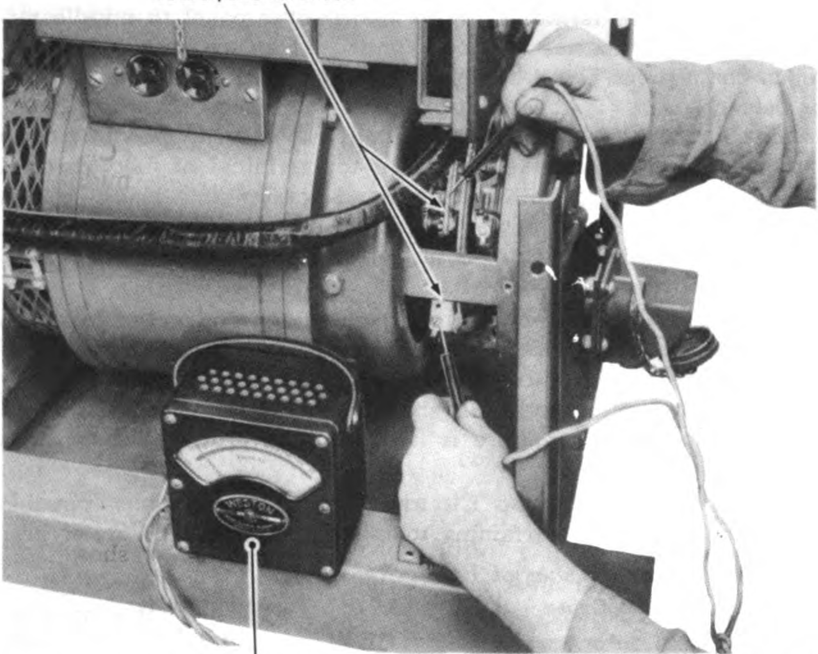

Figure 23 — Testing Exciter Voltage Output

wires indicates a short circuit in the revolving field circuit. If field is short-circuited, disassemble generator and repair or replace defective parts. This test is the same for the single-phase Unit M6, except that the change-over bar is connected between change-over panel terminals "2" and "3" instead of "1" and "2." If it is necessary to replace resistor, it is connected on rear of change-over panel between terminals "2" and "3." This test of the single- and 3-phase Unit M6 is the same as that outlined for the Unit M5, except that instead of connecting a change-over bar between change-over panel terminals "1" and "2," a wire jumper is connected across the resistor in the exciter field circuit.

10. If step *9* above shows exciter generating no voltage, examine commutator brushes to see if they are stuck in holders, broken, or worn. Replace if broken or worn. Examine brush holder springs to see that brushes are under tension and against commutator. Replace weak or broken springs. If brushes are operating satisfactorily, test for open circuit from top right-hand exciter brush to terminal "2" on change-over panel. Open circuit here indicates poor field connection on this brush holder or an open exciter field circuit. Disassemble

generator and repair or replace open exciter field coils. Check for open circuit from terminal "2" on change-over panel to middle terminal on field rheostat (voltage control). Replace wire if open or repair connections. Check for open circuit from top to middle terminal of field rheostat (voltage control) with field rheostat turned to extreme clockwise position. Replace field rheostat if open circuit is indicated. Test for open circuit from top terminal of field rheostat (voltage control) to bottom right-hand commutator brush holder. Repair or replace wire if open. If above procedure reveals no fault, a defective exciter armature is probable. Disassemble generator and repair or replace exciter armature.

11. If step *9* above shows exciter generating voltage, but less than 56 volts, follow the procedure outlined in step *10* above. Look especially for a high resistance or loose connection, faulty resistor, faulty field rheostat (voltage control), short circuit in exciter field coil, or a faulty armature. If armature is faulty, it will probably show signs of heat.

(7) TROUBLE SHOOTING CHART. Possible malfunctions, possible causes, and remedies pertaining to main generator and exciter are:

(a) Arcing at Brushes of Exciter.

Possible Cause	Possible Remedy
Dirt on commutator.	Clean commutator.
Worn brushes.	Replace brushes (par. 24 **b** (10)).
Brushes stuck in holders.	Remove, clean, and install brush holder and brush (pars. 24 **b** (9) and (10) and 27 **b** (1) through (4)).
Open circuit in armature coil in exciter.	Replace armature (par. 24).
Open circuit in main generator lead to field rheostat.	Solder lead (par. 26 **b** (1) *(b)* *1*).

(b) Fails to Generate Rated Amperes.

Unbalanced load on lines.	Balance load on lines.
Defective wiring in circuit.	Replace or repair wiring (par. 24).
Bars on change-over panel connected incorrectly.	Connect change-over panel bars correctly (par. 29 **b** (1) and (2)).
Field rheostat incorrectly adjusted.	Adjust field rheostat correctly.
Dirt on exciter commutator.	Clean exciter commutator.
Worn brushes on exciter.	Replace exciter brushes.
Defective rotor.	Replace rotor (par. 24 **a** through **b** (4)).

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Possible Cause	Possible Remedy
Short circuit in revolving field coil.	Replace revolving field coil (par. 24 a through b (7)).
Open circuit in revolving field coil.	Replace revolving field coil (par. 24 a through b (7)).
Grounded revolving field coil.	Replace revolving field coil (par. 24 a through b (7)).
Open circuit in field coil lead.	Solder field coil lead (par. 26 b (1) *(a) 1*).
Short circuit in field coil lead.	Replace field coil lead (par. 26 b (1) *(a) 3*).
Fuse burned out.	Replace burned out fuse.
No load on generator.	Put load on generator.
Defective ammeter.	Replace ammeter (par. 36).

(c) Fails to Operate at Proper Frequency.

Bars on change-over panel connected incorrectly.	Connect change-over panel bars correctly (par. 29 b (1) and (2)).
Defective wiring in circuit.	Repair wiring (par. 26 b (1)).
Engine speed too low or too high.	Adjust engine speed (par. 148),

(d) Generator Delivers No Voltage or Amperage.

No load on generator.	Connect generator to load.
Circuit breaker off.	Turn on circuit breaker.
Dirt on commutator of exciter.	Clean commutator.
Exciter brushes stuck in holders.	Remove, clean, and install brush holder and brush (pars. 24 b (9) and (10) and 27 b (1) through (4)).
Worn exciter brushes.	Replace exciter brushes.
Open circuit in revolving field coil.	Replace revolving field coil (par. 24 a through b (7)).
Open circuit in field coil lead.	Connect and solder field coil lead par. 26 b (1) *(a)*).
Defective rotor.	Replace rotor (par. 24 a through b (4)).
Grounded revolving field coil.	Replace revolving field coil (par. 24 a through b (7)).
Fuses blown out.	Replace fuses.
Change-over panel incorrectly connected.	Connect change-over panel correctly (pars. 27 b (11) *(e)* and 29 b (1) and (2)).
Open circuit in stator winding.	Replace body and stator (par. 24 b (1) through (5)).
Open circuit in wiring from change-over panel to instrument panel.	Test (par. 22 b (6) *(d)*) and repair or replace welding.

Possible Cause	Possible Remedy
Open circuit between stator and change-over panel.	Test (par. 22 **b** (6) *(d)*) and repair or replace wiring.

(e) Generator Delivers No Voltage.

Defective voltmeter.	Replace voltmeter (par. 35).
Change-over panel improperly connected.	Connect change-over panel properly (par. 27 **b** (11) *(e)*).
Change-over panel bars not connected.	Connect change-over panel bars (par. 29 **b** (1) and (2)).

(f) Voltmeter Shows No Voltage.

Fuse "A" burned out.	Replace fuse "A."
Open circuit in circuit "A."	Replace or repair wiring (par. 24).
Defective voltmeter.	Replace voltmeter (par. 35).

(g) Ammeter Registers Too High.

Defective ammeter.	Replace ammeter (par. 36).
Fuse "B" burned out.	Replace fuse "B."
Open circuit in "B" circuit.	Repair or replace wiring (par. 24).
Change-over panel incorrectly connected.	Connect change-over panel correctly (par. 27 **b** (11) *(e)*).
Improperly balanced load.	Balance load.

23. REMOVAL.

a. Equipment.

HOIST, chain
SCREWDRIVER
WRENCH, open-end, 3/8-in.
WRENCH, open-end, 1/2-in.
WRENCH, open-end, 9/16-in.
WRENCH, open-end, 3/4-in.
WRENCH, Stillson

b. Procedure.

(1) Remove housing (par. 14).

(2) Disconnect starter switch to starting motor cable from starting motor (9/16-in. open-end wrench).

(3) Remove the wire from the ammeter to battery charging generator regulator at the regulator (screwdriver) (fig. 133).

(4) Remove ignition switch to ignition coil wire from ignition coil terminal marked "—" (3/8-in. open-end wrench) (fig. 133).

(5) Disconnect choke control from carburetor and air cleaner bracket (par. 154).

(6) Disconnect oil pressure gage line from cylinder block (1/2-in. open-end wrench) (fig. 133).

(7) Remove main generator front grease cup (1/2-in. open-end wrench). Remove main generator front grease cup elbow and nipple (Stillson wrench) (fig. 133).

MAIN GENERATOR AND EXCITER

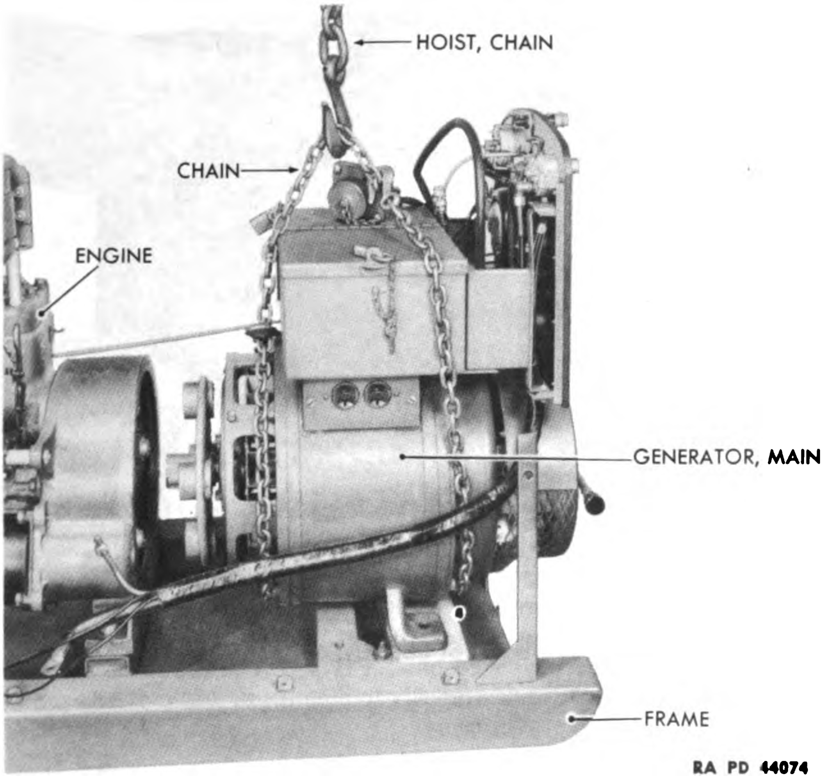

Figure 24 — Lifting Main Generator from Unit

(8) Remove main generator fan cover clamp screws and nuts (screwdriver). Lift fan cover from unit (fig. 133).

(9) Remove eight cap screws and lock washers securing main generator to bell housing ($\frac{9}{16}$-in. open-end wrench) (fig. 134).

(10) Remove outlet receptacle (pars. 62 and 63).

(11) Loosen right-hand engine rear mounting cap screw ($\frac{3}{4}$-in. open-end wrench). Pull battery to starter switch cable from cable clip (fig. 135).

(12) Remove main generator mounting cap screws and lock washers ($\frac{3}{4}$-in. open-end wrench) (fig. 134).

(13) Slide back entire main generator and instrument panel assembly until it clears engine (two men).

(14) Construct a chain or rope sling and carefully lift main generator and instrument panel assembly from unit with a chain hoist (fig. 24).

Possible Cause	Possible Remedy
Open circuit between stator and change-over panel.	Test (par. 22 **b** (6) *(d)*) and repair or replace wiring.

(e) Generator Delivers No Voltage.

Defective voltmeter.	Replace voltmeter (par. 35).
Change-over panel improperly connected.	Connect change-over panel properly (par. 27 **b** (11) *(e)*).
Change-over panel bars not connected.	Connect change-over panel bars (par. 29 **b** (1) and (2)).

(f) Voltmeter Shows No Voltage.

Fuse "A" burned out.	Replace fuse "A."
Open circuit in circuit "A."	Replace or repair wiring (par. 24).
Defective voltmeter.	Replace voltmeter (par. 35).

(g) Ammeter Registers Too High.

Defective ammeter.	Replace ammeter (par. 36).
Fuse "B" burned out.	Replace fuse "B."
Open circuit in "B" circuit.	Repair or replace wiring (par. 24).
Change-over panel incorrectly connected.	Connect change-over panel correctly (par. 27 **b** (11) *(e)*).
Improperly balanced load.	Balance load.

23. REMOVAL.

a. Equipment.

HOIST, chain
SCREWDRIVER
WRENCH, open-end, 3/8-in.
WRENCH, open-end, 1/2-in.
WRENCH, open-end, 9/16-in.
WRENCH, open-end, 3/4-in.
WRENCH, Stillson

b. Procedure.

(1) Remove housing (par. 14).

(2) Disconnect starter switch to starting motor cable from starting motor (9/16-in. open-end wrench).

(3) Remove the wire from the ammeter to battery charging generator regulator at the regulator (screwdriver) (fig. 133).

(4) Remove ignition switch to ignition coil wire from ignition coil terminal marked "—" (3/8-in. open-end wrench) (fig. 133).

(5) Disconnect choke control from carburetor and air cleaner bracket (par. 154).

(6) Disconnect oil pressure gage line from cylinder block (1/2-in. open-end wrench) (fig. 133).

(7) Remove main generator front grease cup (1/2-in. open-end wrench). Remove main generator front grease cup elbow and nipple (Stillson wrench) (fig. 133).

MAIN GENERATOR AND EXCITER

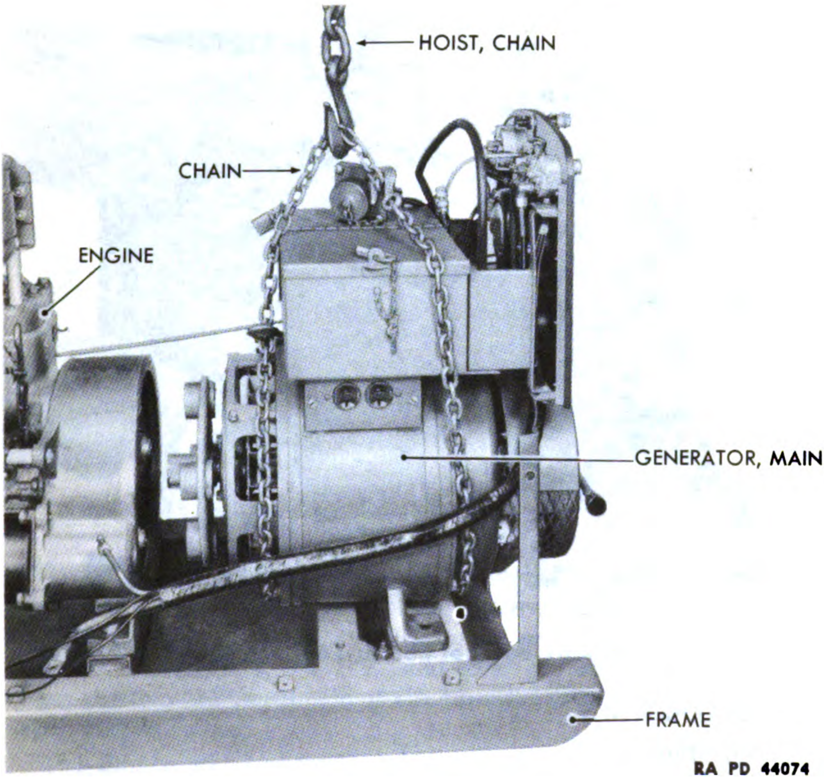

Figure 24 — Lifting Main Generator from Unit

(8) Remove main generator fan cover clamp screws and nuts (screwdriver). Lift fan cover from unit (fig. 133).

(9) Remove eight cap screws and lock washers securing main generator to bell housing (9/16-in. open-end wrench) (fig. 134).

(10) Remove outlet receptacle (pars. 62 and 63).

(11) Loosen right-hand engine rear mounting cap screw (¾-in. open-end wrench). Pull battery to starter switch cable from cable clip (fig. 135).

(12) Remove main generator mounting cap screws and lock washers (¾-in. open-end wrench) (fig. 134).

(13) Slide back entire main generator and instrument panel assembly until it clears engine (two men).

(14) Construct a chain or rope sling and carefully lift main generator and instrument panel assembly from unit with a chain hoist (fig. 24).

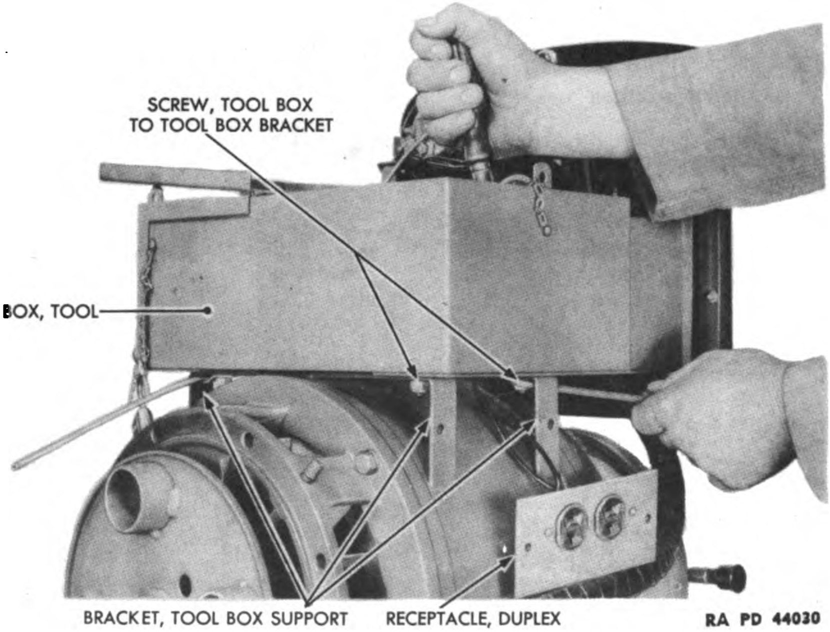

Figure 25 — Removing Tool Box to Tool Box Bracket Screws

24. DISASSEMBLY.

a. Equipment.

CUTTER, wire
HAMMER, soft
HAMMER, 2-lb
MALLET, rawhide
PULLER, bearing
PULLER, gear
SCREWDRIVER
SCREWDRIVER, large
TAG, cardboard (6)
WRENCH, open-end, 5/16-in.
WRENCH, open-end, 11/32-in.
WRENCH, open-end, 7/16-in.
WRENCH, open-end, 1/2-in.
WRENCH, open-end, 9/16-in.
WRENCH, socket, 1/2-in.
WRENCH, socket, 9/16-in.
WRENCH, socket-head set-screw, 1/8-in.
WRENCH, socket-head set-screw, 5/16-in.
WRENCH, Stillson

b. Procedure.

(1) REMOVE INSTRUMENT PANEL, TOOL BOX, AND CHANGE-OVER PANEL.

SCREWDRIVER
WRENCH, open-end, 5/16-in.
WRENCH, open-end, 7/16-in.
WRENCH, open-end, 1/2-in.

(a) Unit M5. Disconnect main generator leads from back of change-over panel terminals "1," "1A," "1B," "1C," "A," "B," and "C" (1/2-in. open-end wrench) (fig. 71).

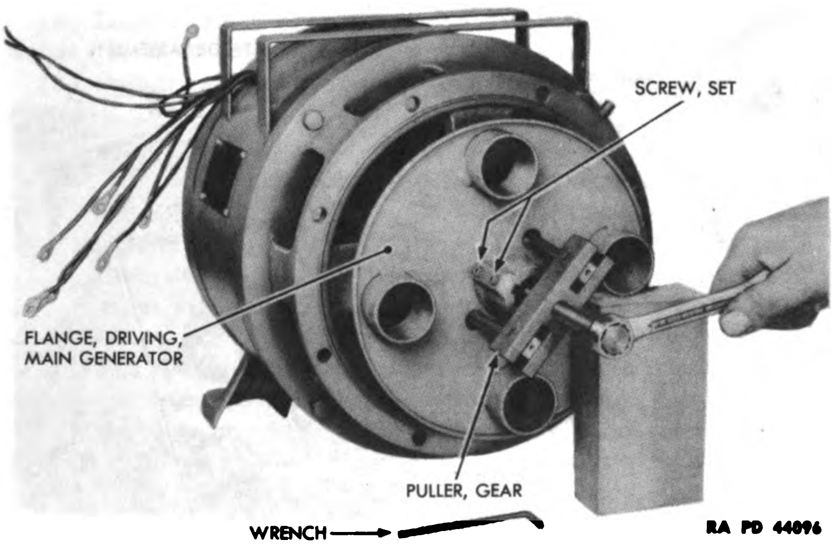

Figure 26 — Pulling Main Generator Driving Flange

(b) Single-phase Unit M6. Disconnect main generator leads from back of terminals "2," "4," "5," and "5A" of change-over panel, and from the two "M" terminals of the time delay relay (7/16- and 3/8-in. open-end wrenches).

(c) Single- and 3-phase Unit M6. Disconnect main generator leads from bottom clips of fuses "A," "B," and "C," and from the two "M" terminals of the time delay relay (7/16-in. open-end wrench).

(d) Disconnect main generator leads (5/16-in. open-end wrench) (fig. 66) from top terminal of field rheostat (voltage control).

(e) Remove screws and safety nuts (1/2-in. open-end wrench and screwdriver), securing tool box to right-hand bracket.

(f) Remove duplex receptacle to tool box bracket screws, nuts, and lock washers (screwdriver and 7/16-in. open-end wrench). Lift receptacle from bracket (fig. 74).

(g) Remove screws and safety nut which secure tool box to left-hand bracket (1/2-in. open-end wrench and screwdriver).

(h) Lift instrument panel, tool box, and change-over panel assembly from generator. CAUTION: Duplex receptacle must be pushed through tool box bracket as assembly is lifted from generator (fig. 74).

(2) REMOVE MAIN GENERATOR DRIVING FLANGE.

HAMMER, 2-lb
PULLER, gear
WRENCH, socket-head setscrew, 1/8-in.

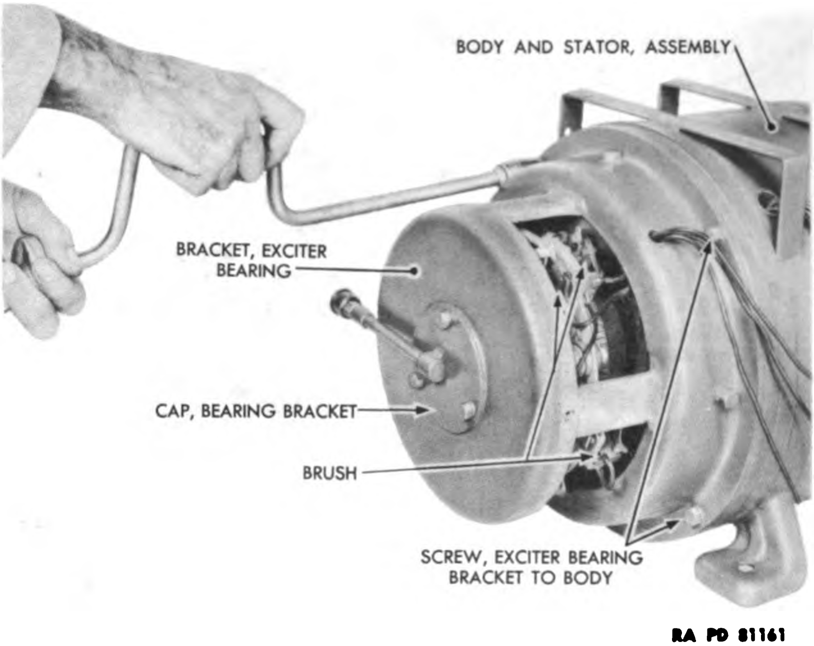

Figure 27 — Removing Exciter Bearing Bracket Assembly

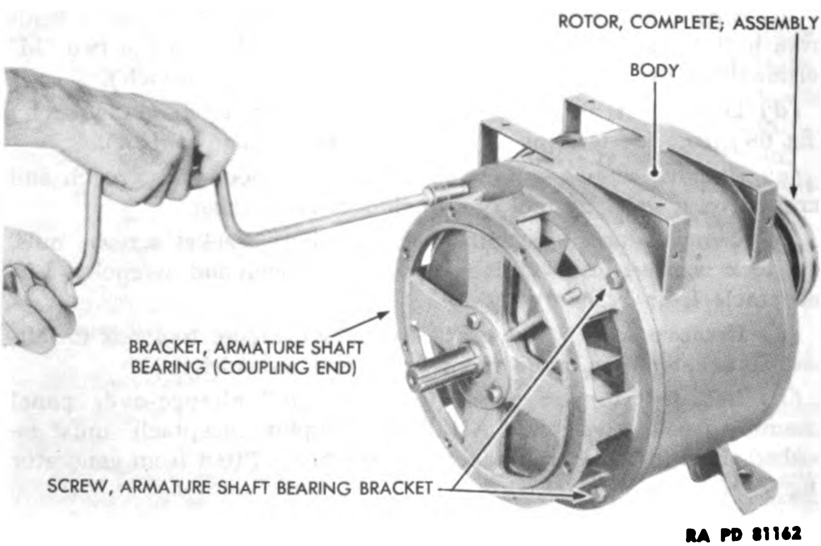

Figure 28 — Removing Armature Shaft Bearing Bracket

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(a) Loosen socket-head setscrews in hub of main generator driving flange (1/8-in. socket-head setscrew wrench) (fig. 26).

(b) Pull driving flange from the rotor assembly shaft (gear puller) (fig. 26).

(c) Tap driving flange key from rotor assembly shaft (hammer).

(3) REMOVE EXCITER BEARING BRACKET ASSEMBLY.

HAMMER, soft	WRENCH, open-end, 7/16-in.
SCREWDRIVER, large	WRENCH, socket, 9/16-in.

(a) Unscrew two main generator brush cover machine screws and nuts, and remove cover from exciter bearing bracket (screwdriver and 7/16-in. open-end wrench).

(b) Lift all eight brushes away from rotor. NOTE: Brush holders are designed so that brushes will stay up (fig. 27).

(c) Remove cap screws and lock washers securing exciter bearing bracket to body and stator assembly (9/16-in. socket wrench) (fig. 27).

(d) Tap exciter bearing bracket loose from body (soft hammer). Pry exciter bearing bracket from body (large screwdriver).

(e) Lift exciter bearing bracket from generator (fig. 27). CAUTION: Brush holder ring is a close fit over slip ring separator. Avoid breaking separator when removing bearing bracket.

(4) REMOVE COMPLETE ROTOR ASSEMBLY.

HAMMER, soft	WRENCH, socket, 9/16-in.

(a) Remove cap screws and lock washers securing armature shaft bearing bracket to body (9/16-in. socket wrench) (fig. 28).

(b) Tap armature shaft bearing bracket loose from body (soft hammer) (fig. 28).

(c) Lift bracket and complete rotor assembly from body and stator assembly.

(5) REMOVE AND DISASSEMBLE ARMATURE SHAFT BEARING BRACKET.

HAMMER, soft	WRENCH, Stillson
WRENCH, open-end, 1/2-in.	

(a) Tap bracket loose from rotor assembly (soft hammer) (fig. 29).

(b) Lift bracket from rotor assembly.

(c) Remove cap screws and lock washers, securing grease retainer to bracket (1/2-in. open-end wrench) (fig. 29).

(d) Lift grease retainer, felt washer, and gasket from the bracket.

(e) Screw rear bearing lubrication pipe nipple from bracket (Stillson wrench) (fig. 29).

(6) DISASSEMBLE BODY AND STATOR ASSEMBLY (fig. 30).

CARDBOARD TAG (6)	SCREWDRIVER
CUTTER, wire	

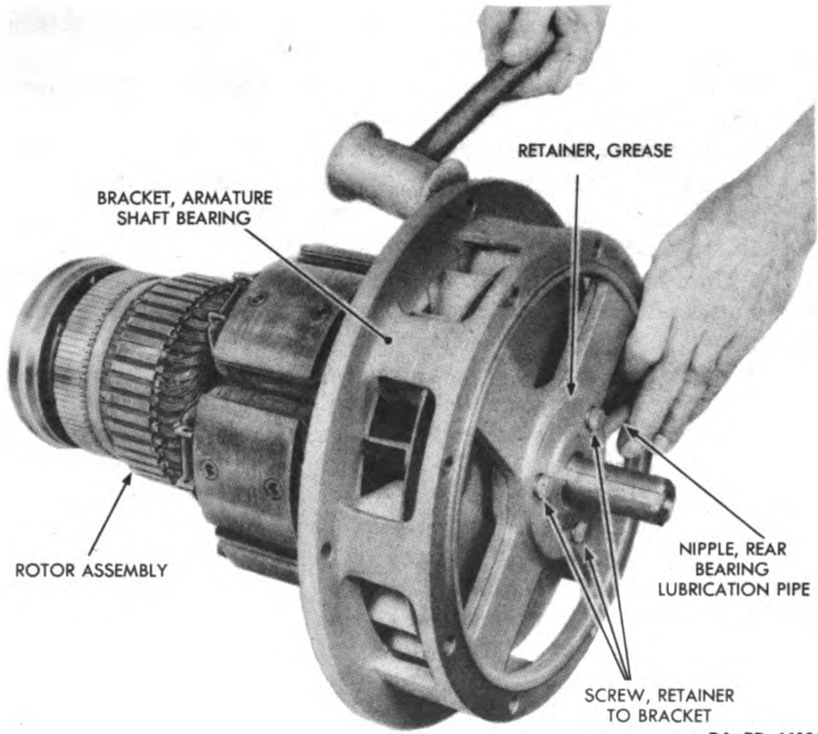

Figure 29 — Removing Armature Shaft Bearing Bracket from Rotor Assembly

(a) Very little disassembly of the body and stator assembly can be done. It is replaced as a unit when defective. Steps in disassembly are:

1. Remove tape from stator coil and main generator lead connection. Cut connection (wire cutter) and pull main generator lead from body. Repeat the step to remove each of the remaining five main generator leads. Tag wires from which leads are removed to aid in assembly (cardboard tags).

2. Pry body bushing from body (fig. 30) (screwdriver).

3. Remove name plate screws (screwdriver). Remove name plate.

(7) DISASSEMBLE COMPLETE ARMATURE ASSEMBLY (fig. 31).

CUTTER, wire	PULLER, bearing
HAMMER, hide-faced, 2-lb	WRENCH, socket-head set-screw, $\frac{5}{16}$-in.

(a) Pull armature shaft bearings from armature shaft (bearing puller). Two men are needed: one to hold the bearing puller, and one to turn the wrench on the puller.

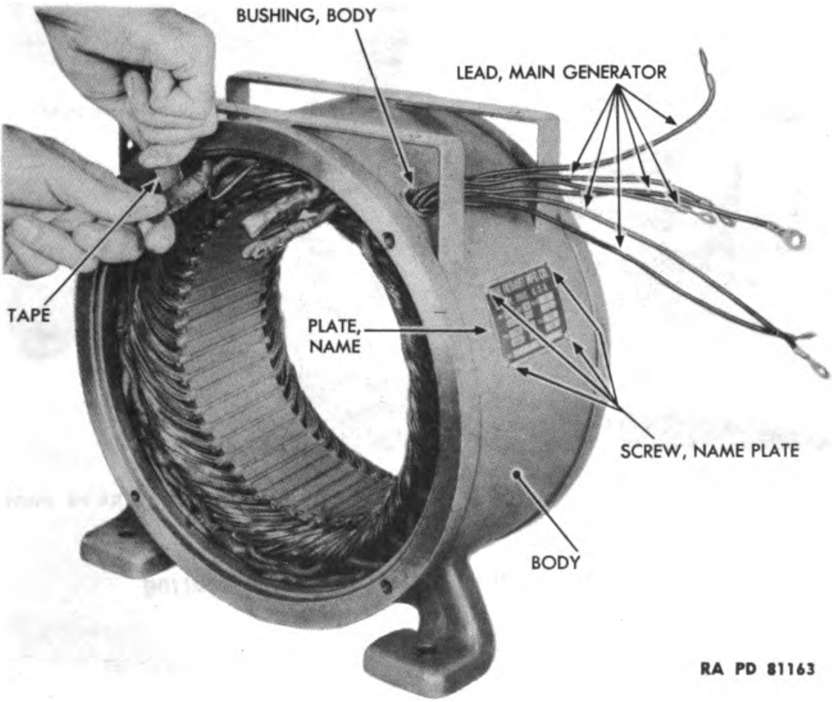

Figure 30 — Removing Main Generator Lead

(b) Remove tape from revolving field coil leads.

(c) Cut leads at point of connection (wire cutter).

(d) Remove pole piece to spider base screws from pole piece ($\frac{5}{16}$-in. socket-head setscrew wrench). Lift pole piece and revolving field coil from rotor assembly. Pick base revolving field coil insulator from under side of coil.

(e) Tap revolving field coil from pole piece (hide-faced hammer). Lift pole piece insulation and top revolving field piece insulator from coil.

(f) Repeat steps *(d)* and *(e)* above to remove remaining five revolving field coils.

(8) Disassemble Exciter Bearing Bracket (fig. 32).

CUTTER, wire	WRENCH, socket, $\frac{9}{16}$-in.
SCREWDRIVER	WRENCH, socket-head set-screw, $\frac{5}{16}$-in.
WRENCH, socket, $\frac{1}{2}$-in.	

(a) Pull main generator leads through hole in exciter bearing bracket and into inside of bracket.

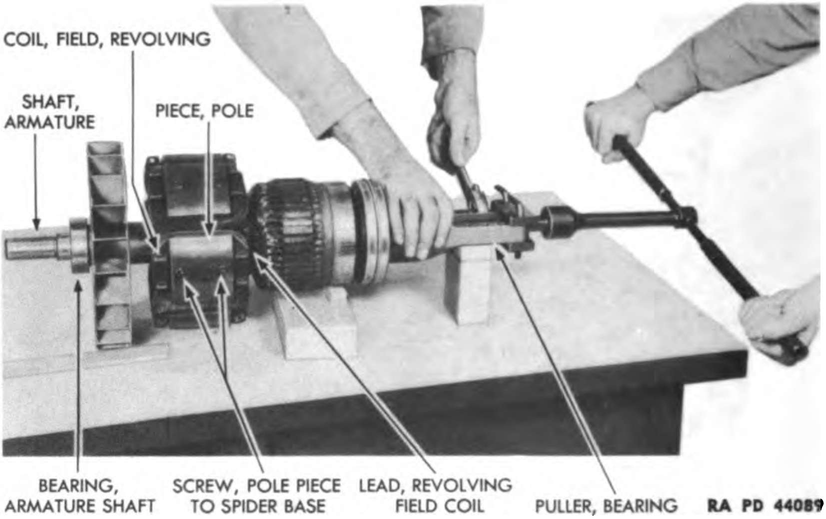

Figure 31 — Pulling Armature Shaft Bearing

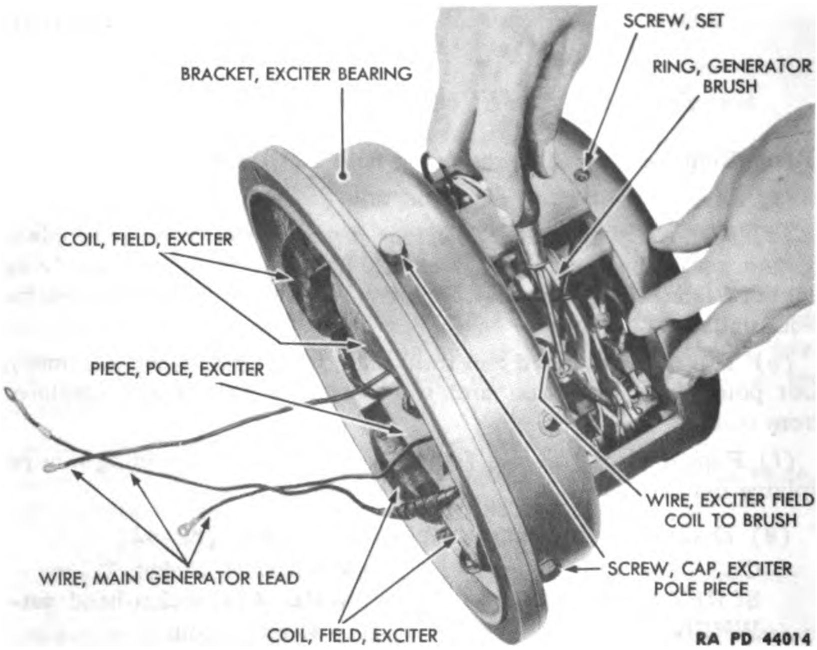

Figure 32 — Disassembling Exciter Bearing Bracket

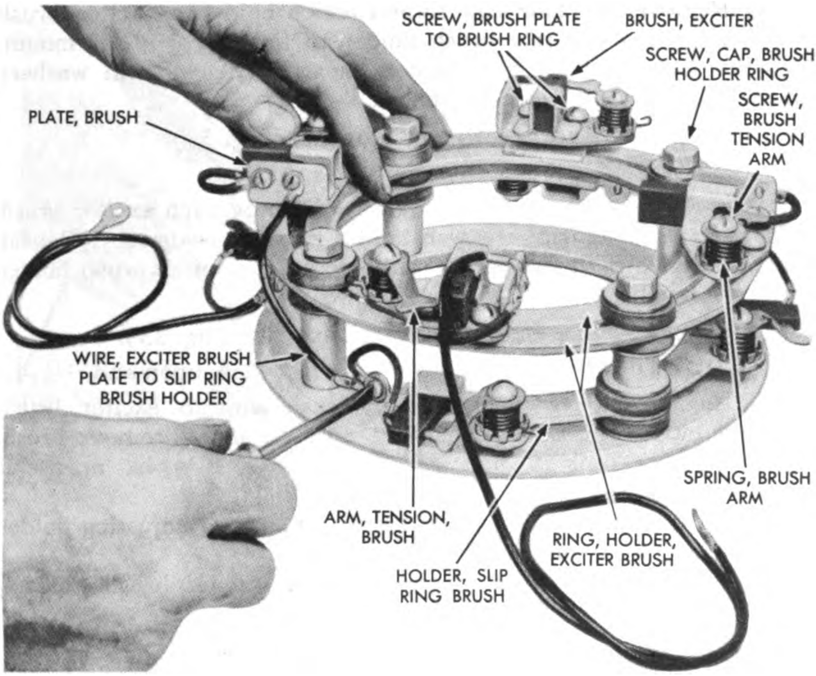

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Figure 33 — Disassembling Generator Brush Ring

(b) Disconnect exciter field coil to brush wire from top right-hand exciter brush holder (screwdriver).

(c) Remove the screws which connect the exciter bearing bracket cap to the exciter bearing bracket (½-in. socket wrench) (fig. 27). Remove lock washers. Lift cap and gasket from exciter bearing bracket.

(d) Remove the four exciter pole piece cap screws and lock washers (9/16-in. socket wrench). Lift all four exciter pole pieces, exciter field coils, and exciter field coil insulators from exciter bearing bracket. Pull four pole pieces and eight exciter pole insulators from exciter field coils (fig. 54). Remove insulating tape and disconnect exciter field coils from each other (wire cutter).

(e) Loosen socket-head setscrews which hold generator brush ring to exciter bearing bracket (5/16-in. socket-head setscrew wrench).

(f) Lift brush ring from exciter bearing bracket.

(9) DISASSEMBLE GENERATOR BRUSH RING (figs. 33 and 52).

SCREWDRIVER WRENCH, socket, 9/16-in.

(a) Remove exciter brush plate wire from slip ring brush holder (screwdriver).

(b) Remove the four cap screws which hold the exciter brush holder ring, and slip ring brush holder to the brush holder mount. Remove lock washers, flat washers, spacers, rocker arm washers, and bushings ($\frac{9}{16}$-in. socket wrench).

(10) REMOVE EXCITER BRUSH HOLDERS (fig. 53).

SCREWDRIVER

Remove two screws and lock washers securing each exciter brush holder to the inner exciter brush holder ring (screwdriver). Repeat step to remove both exciter brush holders from outer brush holder ring.

(11) DISASSEMBLE EXCITER BRUSH HOLDERS (fig. 33).

SCREWDRIVER	WRENCH, open-end, $\frac{11}{32}$-in.

(a) Remove screw which secures brush wire to exciter brush plate (screwdriver). Lift up on brush tension arm and remove brush.

(b) Remove tension arm screw and nut ($\frac{11}{32}$-in. open-end wrench).

(c) Lift tension, screw bushing, spring and spring adjusting holder from exciter brush plate.

(d) To disassemble the remaining three exciter brush holders, repeat steps *(a)*, *(b)*, and *(c)*.

(12) DISASSEMBLE SLIP RING BRUSH HOLDERS.

SCREWDRIVER	WRENCH, open-end, $\frac{11}{32}$-in.

(a) Remove four screws which secure the brush wires to slip ring brush holder (screwdriver). Lift up on brush tension arms, and remove the four brushes.

(b) Remove tension arm screws and nuts ($\frac{11}{32}$-in. open-end wrench and screwdriver).

(c) Lift the four tension arms, screw bushings, springs, and spring adjusting holders from slip ring brush holder.

25. INSPECTION.

a. Equipment.

AIR, compressed	LAMP, test
BATTERY, 6-volt	SCALE
CUTTER, wire ( )	SOLVENT, dry-cleaning
GROWLER, armature	VOLTMETER, direct-current (0- to 7½-volt)
GROWLER, stator	

b. Procedure.

(1) CLEAN THE PARTS.

AIR, compressed	SOLVENT, dry-cleaning

(a) Clean metal parts by washing in SOLVENT, dry-cleaning, and dry with compressed air. Blow dirt from coils and windings with compressed air.

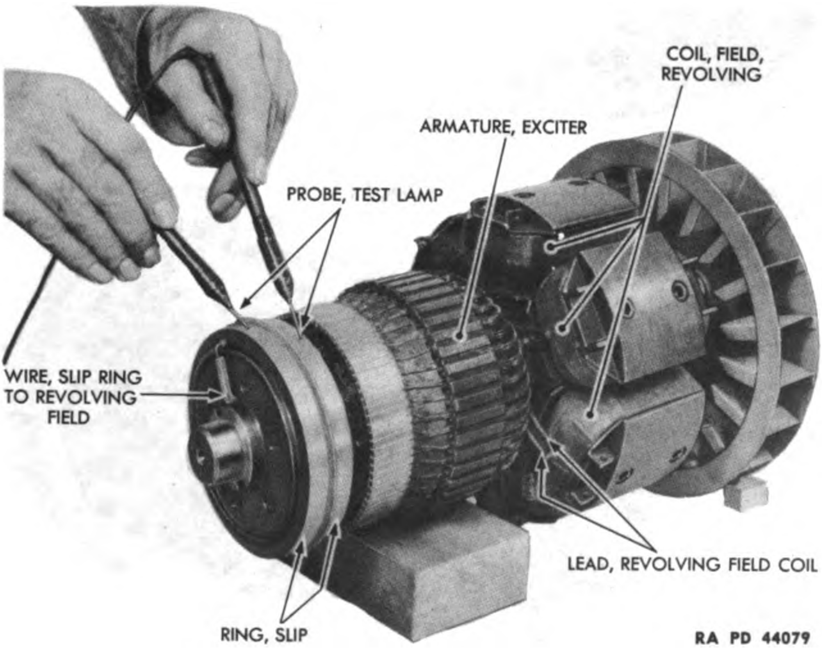

Figure 34 — Testing Revolving Field Coils for Open Circuit

(2) INSPECT ROTOR ASSEMBLY.

BATTERY, 6-volt
GROWLER, armature
LAMP, test
VOLTMETER, direct-current (0- to 7½-volt)

(a) Test revolving field coils for an open circuit by placing a probe of a test lamp on each of the two slip rings (fig. 34). If lamp lights, no open circuit is present. If lamp fails to light, trace revolving field coil wires along armature shaft keyway under exciter armature. Remove tape from connections by which the two wires are joined to field coil leads. Repeat test lamp check with probes on the two exposed connections. If lamp now lights, but did not in the first test, the open circuit is in the slip ring to revolving field coil wires or their connections. If the test lamp still fails to light, remove tape from the connections of field coil leads. Test each coil and each connection individually for an open circuit (fig. 35).

(b) Test revolving field coils for a ground by placing one probe of a test lamp on one slip ring. Place other probe on the armature shaft or paint-free portion of fan (fig. 36). If test lamp fails to light, no ground is present. If test lamp lights, disconnect both leads of each

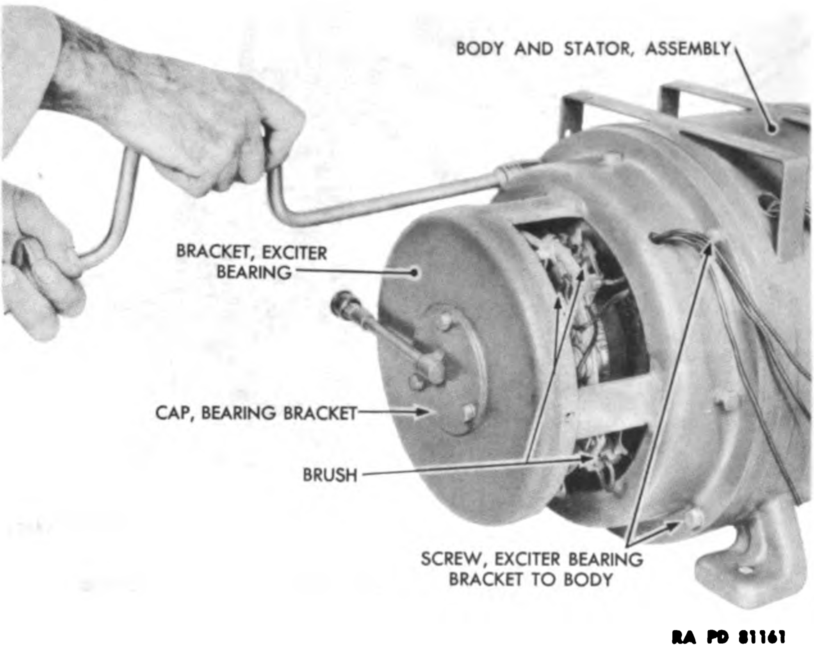

Figure 27 — Removing Exciter Bearing Bracket Assembly

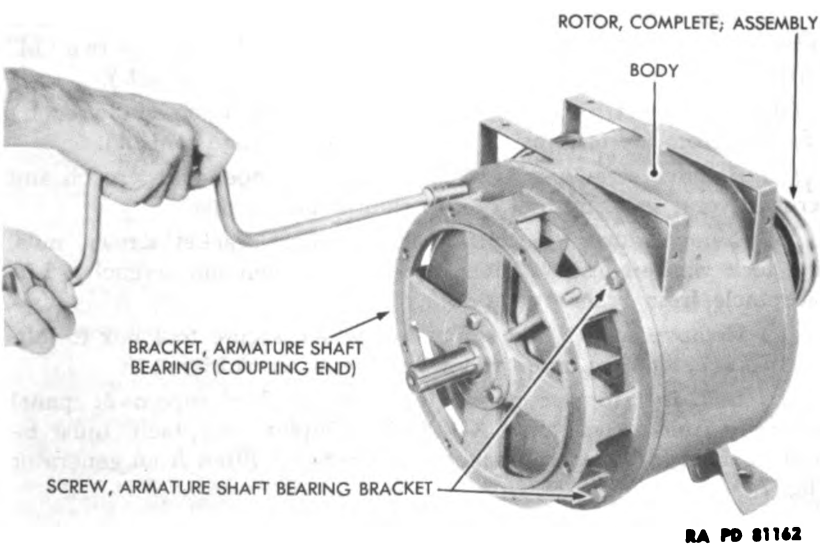

Figure 28 — Removing Armature Shaft Bearing Bracket

MAIN GENERATOR AND EXCITER

(a) Loosen socket-head setscrews in hub of main generator driving flange (1/8-in. socket-head setscrew wrench) (fig. 26).

(b) Pull driving flange from the rotor assembly shaft (gear puller) (fig. 26).

(c) Tap driving flange key from rotor assembly shaft (hammer).

(3) REMOVE EXCITER BEARING BRACKET ASSEMBLY.

HAMMER, soft	WRENCH, open-end, 7/16-in.
SCREWDRIVER, large	WRENCH, socket, 9/16-in.

(a) Unscrew two main generator brush cover machine screws and nuts, and remove cover from exciter bearing bracket (screwdriver and 7/16-in. open-end wrench).

(b) Lift all eight brushes away from rotor. NOTE: Brush holders are designed so that brushes will stay up (fig. 27).

(c) Remove cap screws and lock washers securing exciter bearing bracket to body and stator assembly (9/16-in. socket wrench) (fig. 27).

(d) Tap exciter bearing bracket loose from body (soft hammer). Pry exciter bearing bracket from body (large screwdriver).

(e) Lift exciter bearing bracket from generator (fig. 27). CAUTION: Brush holder ring is a close fit over slip ring separator. Avoid breaking separator when removing bearing bracket.

(4) REMOVE COMPLETE ROTOR ASSEMBLY.

HAMMER, soft	WRENCH, socket, 9/16-in.

(a) Remove cap screws and lock washers securing armature shaft bearing bracket to body (9/16-in. socket wrench) (fig. 28).

(b) Tap armature shaft bearing bracket loose from body (soft hammer) (fig. 28).

(c) Lift bracket and complete rotor assembly from body and stator assembly.

(5) REMOVE AND DISASSEMBLE ARMATURE SHAFT BEARING BRACKET.

HAMMER, soft	WRENCH, Stillson
WRENCH, open-end, 1/2-in.	

(a) Tap bracket loose from rotor assembly (soft hammer) (fig. 29).

(b) Lift bracket from rotor assembly.

(c) Remove cap screws and lock washers, securing grease retainer to bracket (1/2-in. open-end wrench) (fig. 29).

(d) Lift grease retainer, felt washer, and gasket from the bracket.

(e) Screw rear bearing lubrication pipe nipple from bracket (Stillson wrench) (fig. 29).

(6) DISASSEMBLE BODY AND STATOR ASSEMBLY (fig. 30).

CARDBOARD TAG (6)	SCREWDRIVER
CUTTER, wire	

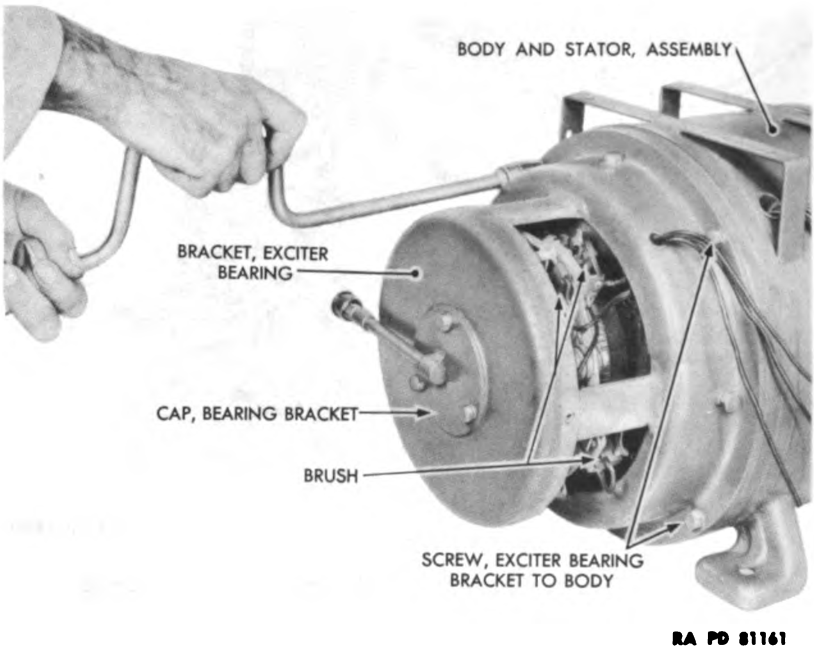

Figure 27 — Removing Exciter Bearing Bracket Assembly

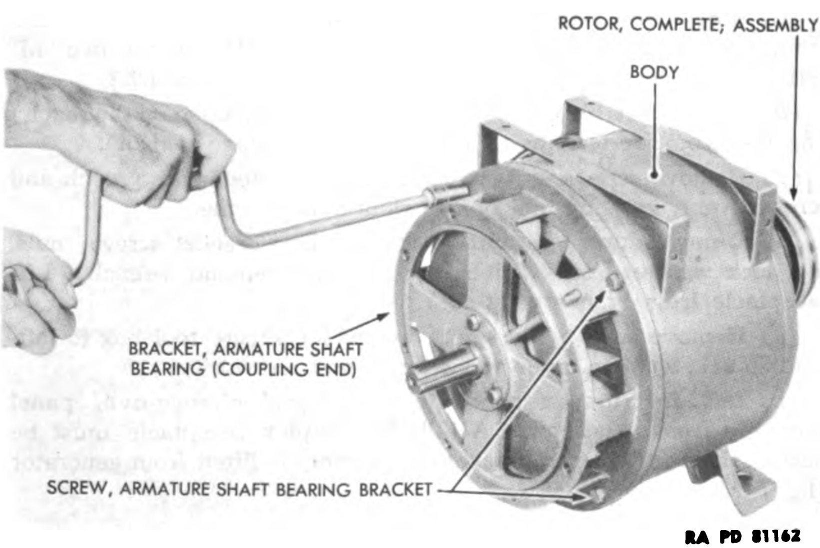

Figure 28 — Removing Armature Shaft Bearing Bracket

MAIN GENERATOR AND EXCITER

(a) Loosen socket-head setscrews in hub of main generator driving flange (1/8-in. socket-head setscrew wrench) (fig. 26).

(b) Pull driving flange from the rotor assembly shaft (gear puller) (fig. 26).

(c) Tap driving flange key from rotor assembly shaft (hammer).

(3) REMOVE EXCITER BEARING BRACKET ASSEMBLY.

HAMMER, soft — WRENCH, open-end, 7/16-in.
SCREWDRIVER, large — WRENCH, socket, 9/16-in.

(a) Unscrew two main generator brush cover machine screws and nuts, and remove cover from exciter bearing bracket (screwdriver and 7/16-in. open-end wrench).

(b) Lift all eight brushes away from rotor. NOTE: Brush holders are designed so that brushes will stay up (fig. 27).

(c) Remove cap screws and lock washers securing exciter bearing bracket to body and stator assembly (9/16-in. socket wrench) (fig. 27).

(d) Tap exciter bearing bracket loose from body (soft hammer). Pry exciter bearing bracket from body (large screwdriver).

(e) Lift exciter bearing bracket from generator (fig. 27). CAUTION: Brush holder ring is a close fit over slip ring separator. Avoid breaking separator when removing bearing bracket.

(4) REMOVE COMPLETE ROTOR ASSEMBLY.

HAMMER, soft — WRENCH, socket, 9/16-in.

(a) Remove cap screws and lock washers securing armature shaft bearing bracket to body (9/16-in. socket wrench) (fig. 28).

(b) Tap armature shaft bearing bracket loose from body (soft hammer) (fig. 28).

(c) Lift bracket and complete rotor assembly from body and stator assembly.

(5) REMOVE AND DISASSEMBLE ARMATURE SHAFT BEARING BRACKET.

HAMMER, soft — WRENCH, Stillson
WRENCH, open-end, 1/2-in.

(a) Tap bracket loose from rotor assembly (soft hammer) (fig. 29).

(b) Lift bracket from rotor assembly.

(c) Remove cap screws and lock washers, securing grease retainer to bracket (1/2-in. open-end wrench) (fig. 29).

(d) Lift grease retainer, felt washer, and gasket from the bracket.

(e) Screw rear bearing lubrication pipe nipple from bracket (Stillson wrench) (fig. 29).

(6) DISASSEMBLE BODY AND STATOR ASSEMBLY (fig. 30).

CARDBOARD TAG (6) — SCREWDRIVER
CUTTER, wire

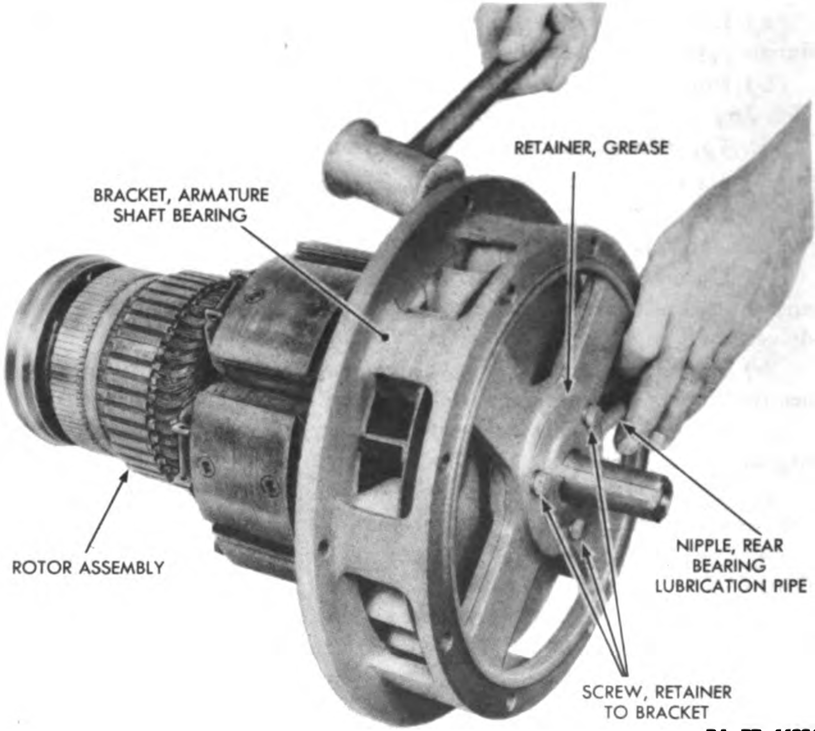

Figure 29 — Removing Armature Shaft Bearing Bracket from Rotor Assembly

(a) Very little disassembly of the body and stator assembly can be done. It is replaced as a unit when defective. Steps in disassembly are:

1. Remove tape from stator coil and main generator lead connection. Cut connection (wire cutter) and pull main generator lead from body. Repeat the step to remove each of the remaining five main generator leads. Tag wires from which leads are removed to aid in assembly (cardboard tags).

2. Pry body bushing from body (fig. 30) (screwdriver).

3. Remove name plate screws (screwdriver). Remove name plate.

(7) DISASSEMBLE COMPLETE ARMATURE ASSEMBLY (fig. 31).

CUTTER, wire	PULLER, bearing
HAMMER, hide-faced, 2-lb	WRENCH, socket-head set-screw, $\frac{5}{16}$-in.

(a) Pull armature shaft bearings from armature shaft (bearing puller). Two men are needed: one to hold the bearing puller, and one to turn the wrench on the puller.

MAIN GENERATOR AND EXCITER

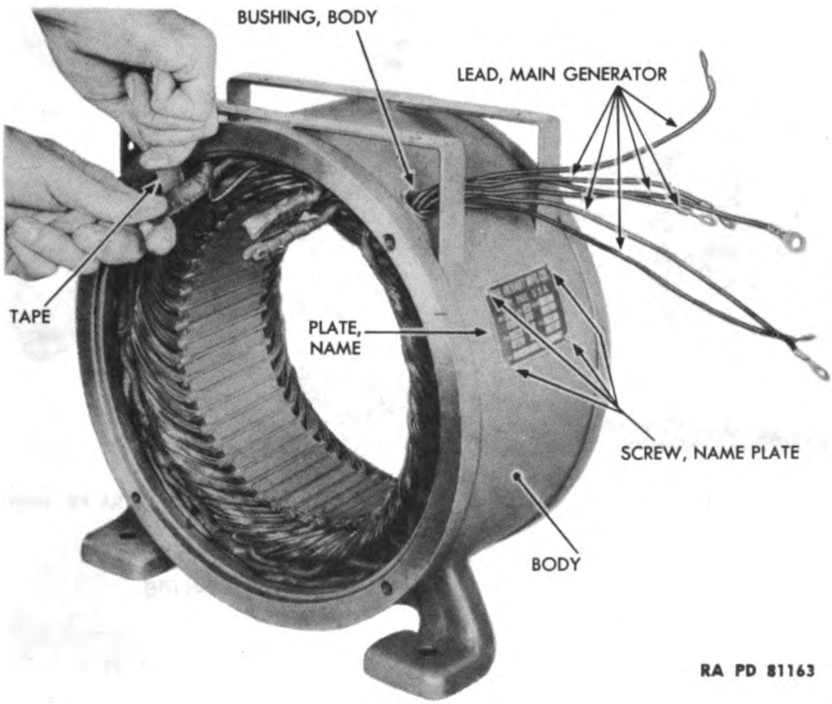

Figure 30 — Removing Main Generator Lead

(b) Remove tape from revolving field coil leads.

(c) Cut leads at point of connection (wire cutter).

(d) Remove pole piece to spider base screws from pole piece (5/16-in. socket-head setscrew wrench). Lift pole piece and revolving field coil from rotor assembly. Pick base revolving field coil insulator from under side of coil.

(e) Tap revolving field coil from pole piece (hide-faced hammer). Lift pole piece insulation and top revolving field piece insulator from coil.

(f) Repeat steps *(d)* and *(e)* above to remove remaining five revolving field coils.

(8) DISASSEMBLE EXCITER BEARING BRACKET (fig. 32).

CUTTER, wire
SCREWDRIVER
WRENCH, socket, 1/2-in.
WRENCH, socket, 9/16-in.
WRENCH, socket-head setscrew, 5/16-in.

(a) Pull main generator leads through hole in exciter bearing bracket and into inside of bracket.

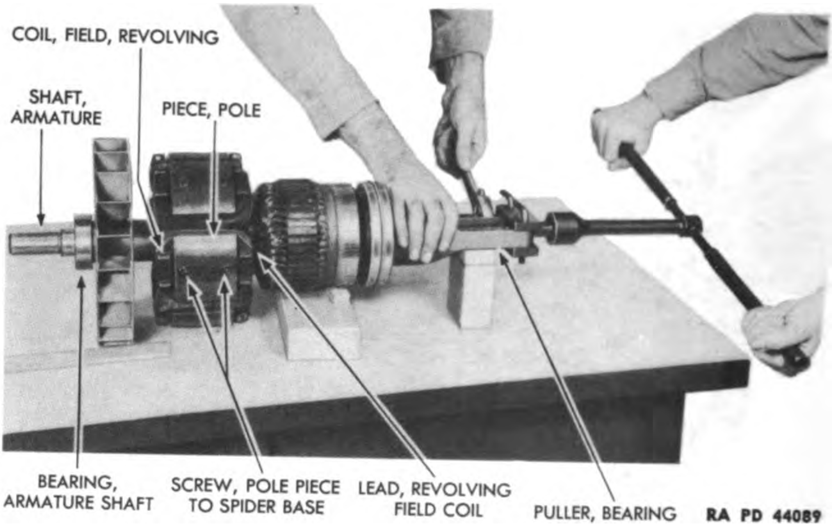

Figure 31 — Pulling Armature Shaft Bearing

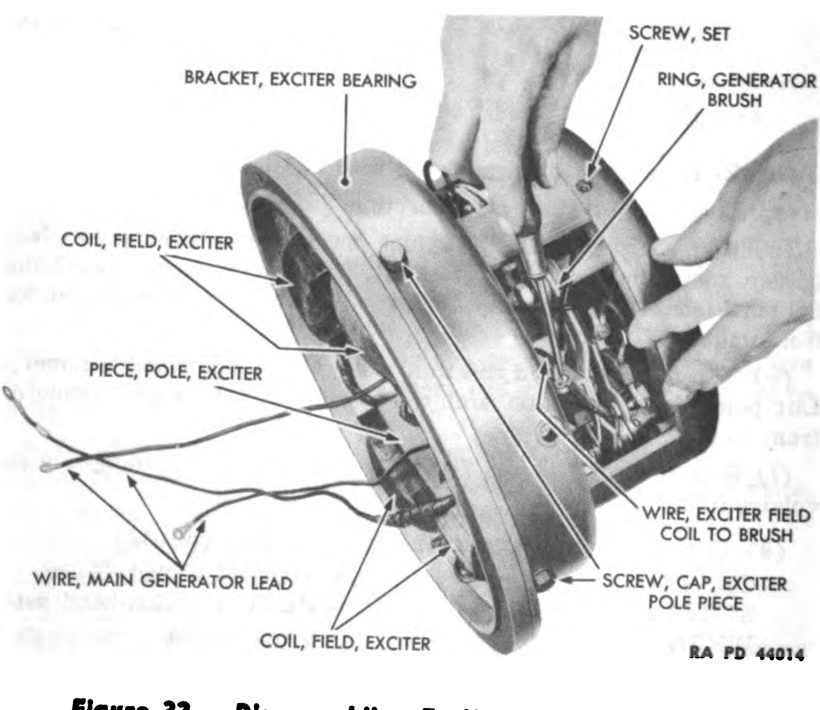

Figure 32 — Disassembling Exciter Bearing Bracket

MAIN GENERATOR AND EXCITER

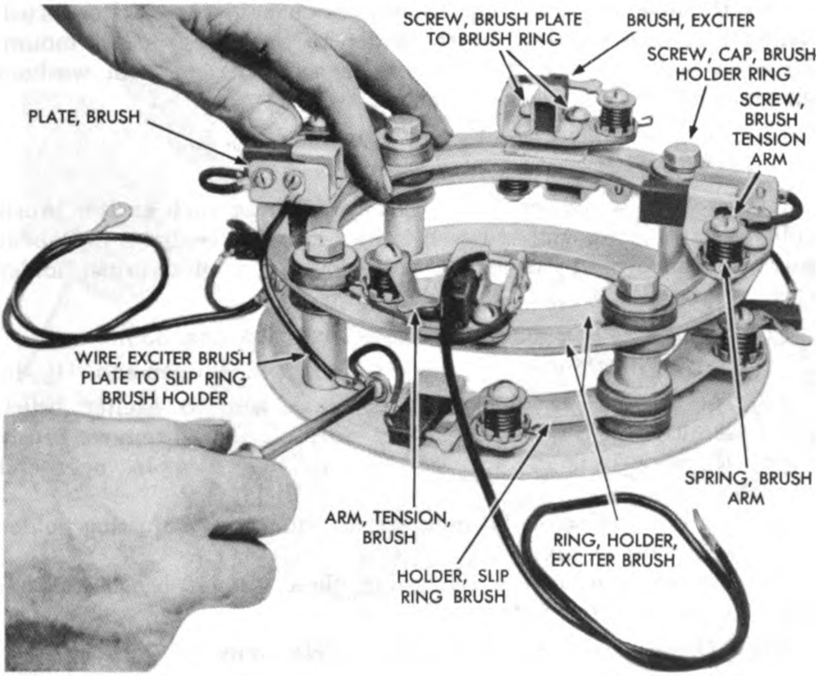

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Figure 33 — Disassembling Generator Brush Ring

(b) Disconnect exciter field coil to brush wire from top right-hand exciter brush holder (screwdriver).

(c) Remove the screws which connect the exciter bearing bracket cap to the exciter bearing bracket (½-in. socket wrench) (fig. 27). Remove lock washers. Lift cap and gasket from exciter bearing bracket.

(d) Remove the four exciter pole piece cap screws and lock washers (9/16-in. socket wrench). Lift all four exciter pole pieces, exciter field coils, and exciter field coil insulators from exciter bearing bracket. Pull four pole pieces and eight exciter pole insulators from exciter field coils (fig. 54). Remove insulating tape and disconnect exciter field coils from each other (wire cutter).

(e) Loosen socket-head setscrews which hold generator brush ring to exciter bearing bracket (5/16-in. socket-head setscrew wrench).

(f) Lift brush ring from exciter bearing bracket.

(9) DISASSEMBLE GENERATOR BRUSH RING (figs. 33 and 52).

SCREWDRIVER WRENCH, socket, 9/16-in.

(a) Remove exciter brush plate wire from slip ring brush holder (screwdriver).

(b) Remove the four cap screws which hold the exciter brush holder ring, and slip ring brush holder to the brush holder mount. Remove lock washers, flat washers, spacers, rocker arm washers, and bushings ($^9/_{16}$-in. socket wrench).

(10) REMOVE EXCITER BRUSH HOLDERS (fig. 53).

SCREWDRIVER

Remove two screws and lock washers securing each exciter brush holder to the inner exciter brush holder ring (screwdriver). Repeat step to remove both exciter brush holders from outer brush holder ring.

(11) DISASSEMBLE EXCITER BRUSH HOLDERS (fig. 33).

SCREWDRIVER — WRENCH, open-end, $^{11}/_{32}$-in.

(a) Remove screw which secures brush wire to exciter brush plate (screwdriver). Lift up on brush tension arm and remove brush.

(b) Remove tension arm screw and nut ($^{11}/_{32}$-in. open-end wrench).

(c) Lift tension, screw bushing, spring and spring adjusting holder from exciter brush plate.

(d) To disassemble the remaining three exciter brush holders, repeat steps *(a)*, *(b)*, and *(c)*.

(12) DISASSEMBLE SLIP RING BRUSH HOLDERS.

SCREWDRIVER — WRENCH, open-end, $^{11}/_{32}$-in.

(a) Remove four screws which secure the brush wires to slip ring brush holder (screwdriver). Lift up on brush tension arms, and remove the four brushes.

(b) Remove tension arm screws and nuts ($^{11}/_{32}$-in. open-end wrench and screwdriver).

(c) Lift the four tension arms, screw bushings, springs, and spring adjusting holders from slip ring brush holder.

25. INSPECTION.

a. Equipment.

AIR, compressed	LAMP, test
BATTERY, 6-volt	SCALE
CUTTER, wire ( )	SOLVENT, dry-cleaning
GROWLER, armature	VOLTMETER, direct-current (0- to 7½-volt)
GROWLER, stator	

b. Procedure.

(1) CLEAN THE PARTS.

AIR, compressed — SOLVENT, dry-cleaning

(a) Clean metal parts by washing in SOLVENT, dry-cleaning, and dry with compressed air. Blow dirt from coils and windings with compressed air.

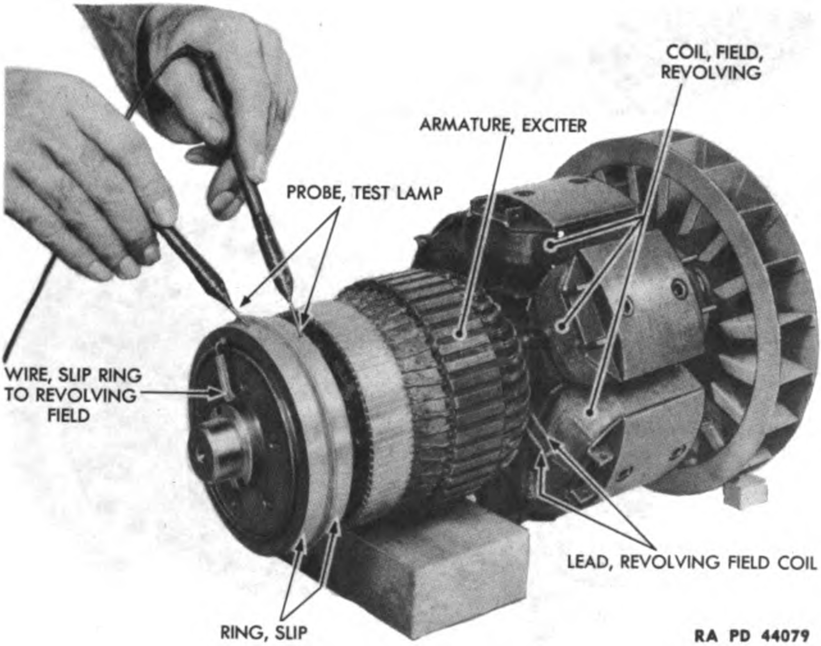

Figure 34 — Testing Revolving Field Coils for Open Circuit

(2) INSPECT ROTOR ASSEMBLY.

BATTERY, 6-volt
GROWLER, armature
LAMP, test
VOLTMETER, direct-current (0- to 7½-volt)

(a) Test revolving field coils for an open circuit by placing a probe of a test lamp on each of the two slip rings (fig. 34). If lamp lights, no open circuit is present. If lamp fails to light, trace revolving field coil wires along armature shaft keyway under exciter armature. Remove tape from connections by which the two wires are joined to field coil leads. Repeat test lamp check with probes on the two exposed connections. If lamp now lights, but did not in the first test, the open circuit is in the slip ring to revolving field coil wires or their connections. If the test lamp still fails to light, remove tape from the connections of field coil leads. Test each coil and each connection individually for an open circuit (fig. 35).

(b) Test revolving field coils for a ground by placing one probe of a test lamp on one slip ring. Place other probe on the armature shaft or paint-free portion of fan (fig. 36). If test lamp fails to light, no ground is present. If test lamp lights, disconnect both leads of each

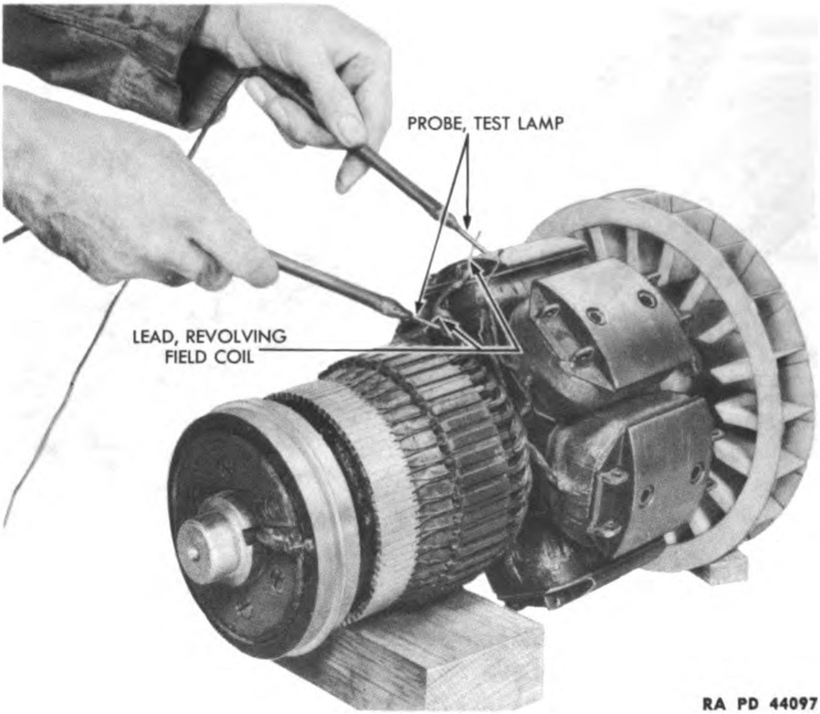

Figure 35 — Testing a Single Revolving Field Coil for Open Circuit

coil and repeat test on each. Place one probe on bare end of one of disconnected leads. Place other probe on armature shaft or fan (fig. 37). Similarly test each revolving field coil wire. Each time the test lamp lights, a grounded coil or wire is indicated.

(c) Test revolving field coils for a short circuit by connecting a 6-volt battery to the two slip rings. Using a 0- to 7½-volt voltmeter equipped with sharp probes, measure voltage drop across each coil. This is done by inserting one probe into one lead of a coil. Insert the other probe into the other lead. Observe the reading of the voltmeter. Repeat test on each of the coils, observing voltmeter each time. If any coil has a reading appreciably less than the others, a short circuit is indicated in that coil. NOTE: If the voltmeter hand moves in the wrong direction, reverse the probes (fig. 38).

(d) Test the exciter armature for a ground with test lamp. Place one probe on a commutator bar. Place the other probe on the armature shaft or paint-free portion of the fan (fig. 39). If lamp lights, a ground is indicated. Failure of the lamp to light shows no ground to be present.

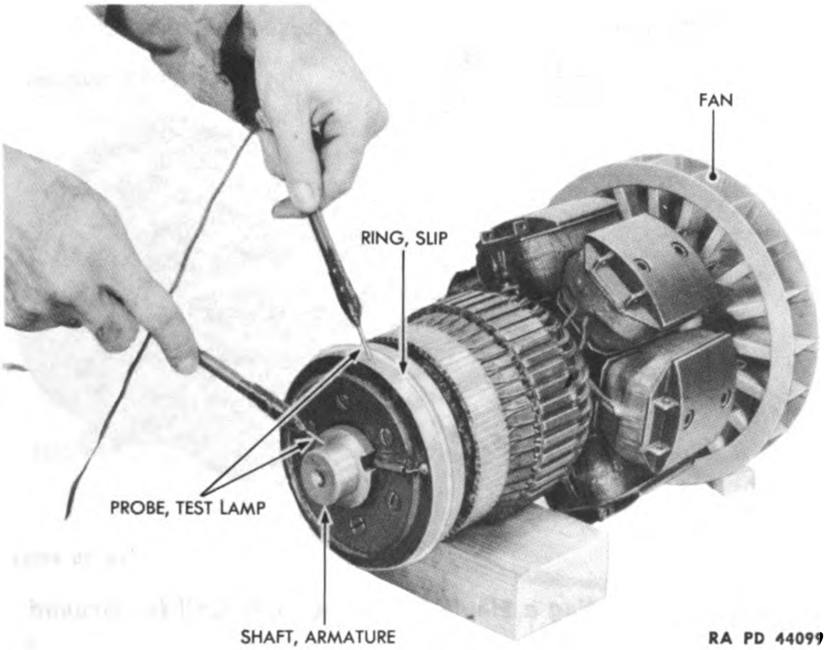

Figure 36 — Testing Revolving Field Coils for Ground

(e) Test exciter armature for a short circuit by placing it in an armature growler (fig. 40). Turn on the growler. Move the steel strip slowly around the armature coils. Keep it parallel with the shaft. Turn off the growler and revolve the armature one-half turn in the growler. Turn on the growler and test the other side of the armature. If the steel strip vibrates noticeably or is drawn to the laminations, a short circuit is indicated.

(f) Inspect the commutator bars (fig. 39). Look for burs which might short circuit two adjacent bars. Observe whether or not bars are scored.

(g) Inspect slip rings to see if they are scored (this is a rare condition). Examine slip ring separator to see if it has been broken due to improper disassembly (fig. 40).

(h) Examine generator armature shaft bearings to see if they are worn or broken. Examine balls and races to see if they are nicked or scored. Slide bearing on shaft (fig. 40). Grasp outer race and attempt to rock bearing on shaft. Presence of perceptible play indicates wear. If bearings are damaged, examine armature shaft to see if it is scored.

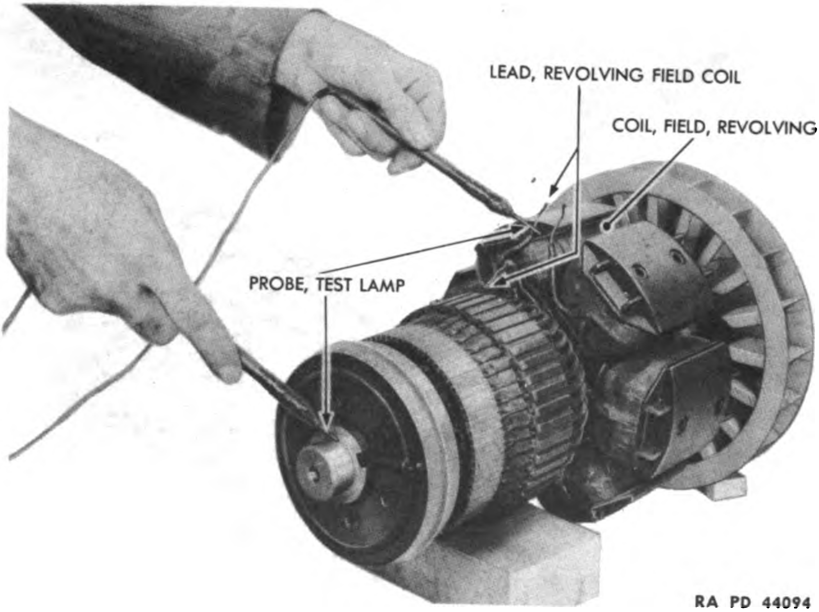

Figure 37 — Testing a Single Revolving Field Coil for Ground

(i) Inspect fan to see if it is bent, or if the weld has broken where fan is attached to armature shaft (fig. 40).

(3) INSPECT BODY AND STATOR.

GROWLER, stator LAMP, test

(a) Test stator windings for an open circuit (test lamp). Place one probe on the tip of any one of the six main generator leads from stator. Touch each of the five remaining leads, one at a time, with the other probe (fig. 41). If lamp fails to light when any one of the leads is touched, an open circuit is indicated. If the lamp lights each time, no open circuit is indicated.

(b) Test the stator windings for a ground (test lamp). Place one test lamp probe against an unpainted surface on the body. Place the other probe against tip of any one of the six main generator leads (fig. 42). If lamp lights, a ground is indicated. If lamp fails to light, no ground is present.

(c) Test stator windings for a short circuit (stator growler). Place growler within body and stator so that steel strip is parallel and next to stator laminations (fig. 43). Turn on growler. Move growler slowly around entire inner circumference of stator. If stator windings have a short circuit, growler will "growl," due to vibration of the steel switch.

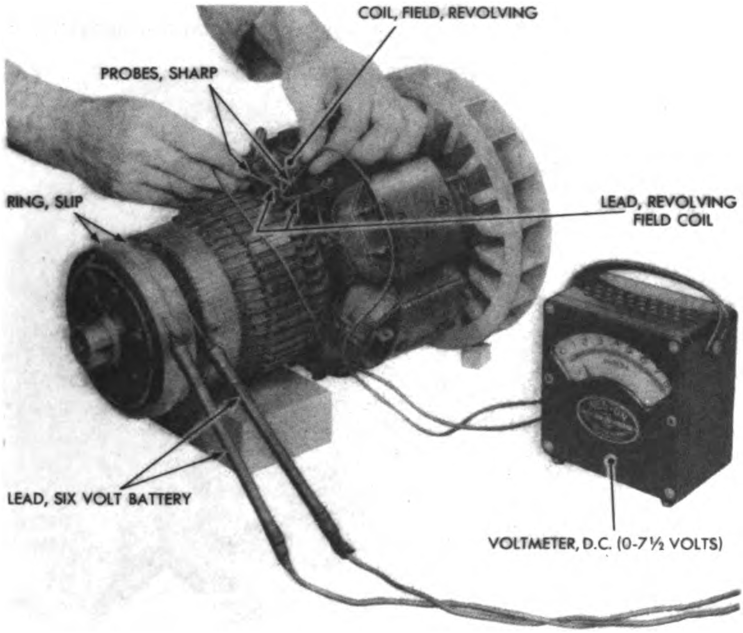

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Figure 38 — Testing Revolving Field Coils for Short Circuit

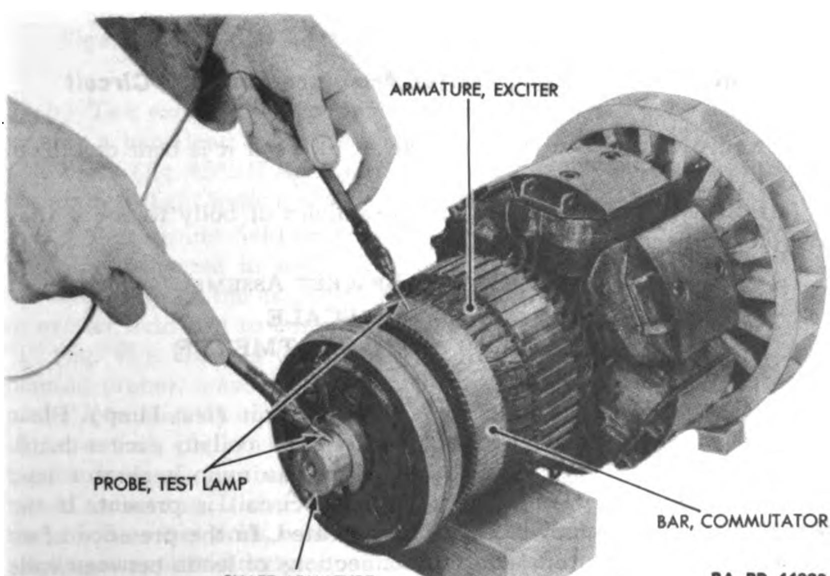


Figure 39 — Testing Exciter Armature for Ground

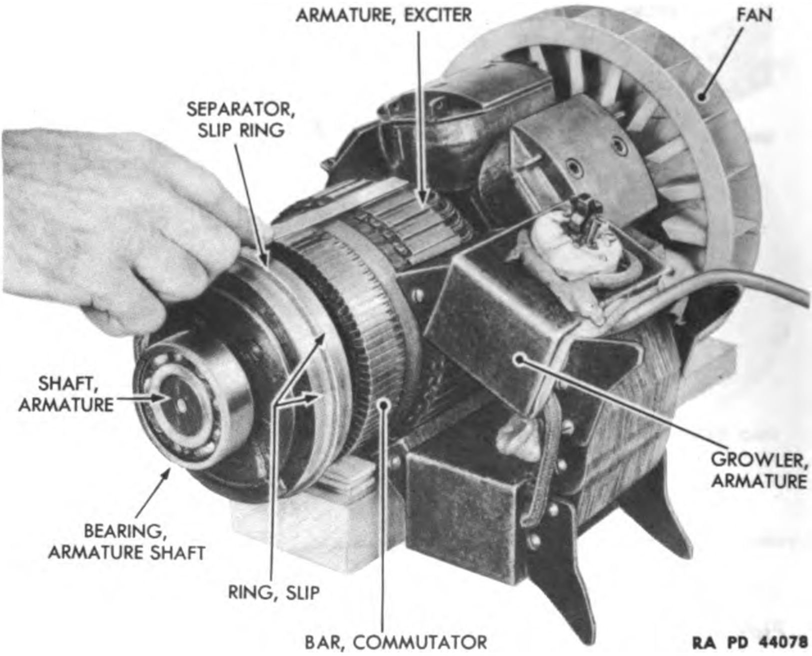


Figure 40 — Testing Exciter Armature for Short Circuit

(d) Inspect tool box support bracket to see if it is bent or broken (fig. 43).

(e) Inspect threads tapped in screw holes of body to see if they are burred or stripped (fig. 43).

(4) INSPECT EXCITER BEARING BRACKET ASSEMBLY.

BATTERY, 6-volt	SCALE
CUTTER, wire	VOLTMETER
LAMP, test	

(a) Test exciter field coils for an open circuit (test lamp). Place one probe of test lamp on tip of exciter field coil to exciter brush wire. Touch the other probe to the tip of the main generator lead "1" (fig. 44). If the lamp lights, no open circuit is present. If the lamp fails to light, an open circuit is indicated. In the presence of an open circuit, remove tape and cut connections of leads between coils (wire cutter). Test each coil individually (test lamp). If the lamp fails to light, an open circuit is indicated.

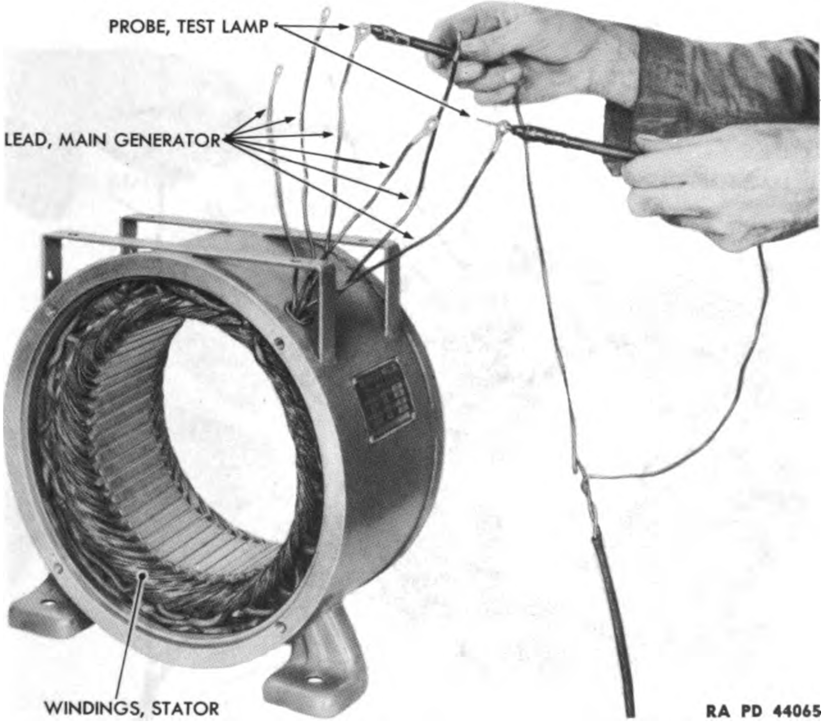


Figure 41 — Testing Stator Windings for Open Circuit

(b) Test exciter field coils for ground (test lamp). Hold one probe against a bare lead from the coil. Place the other probe against the pole piece (fig. 45). If the lamp lights, a ground is present. Failure of the lamp to light indicates coil is free of grounds.

(c) Test exciter field coils for short circuits. This test is made with all coils connected in series. It can be made with coils installed in, or removed from, the exciter bearing bracket. Connect a 6-volt battery to exciter field coil to commutator wire, and to main generator lead "1" (fig. 46). Using a 0- to 7½-volt voltmeter equipped with sharp pointed probes, measure the voltage drop across each coil. Push one probe into lead of a coil. Push the other probe into the other lead of same coil (fig. 46). Observe reading on the voltmeter. Repeat test on each of remaining three coils, observing reading on the voltmeter each time. If the reading on one coil is appreciably less than that of the other coils, a short circuit in that coil is indicated. If the reading is approximately equal on all coils, no short circuit is present. NOTE: If voltmeter hand moves in the wrong direction, reverse the probes.

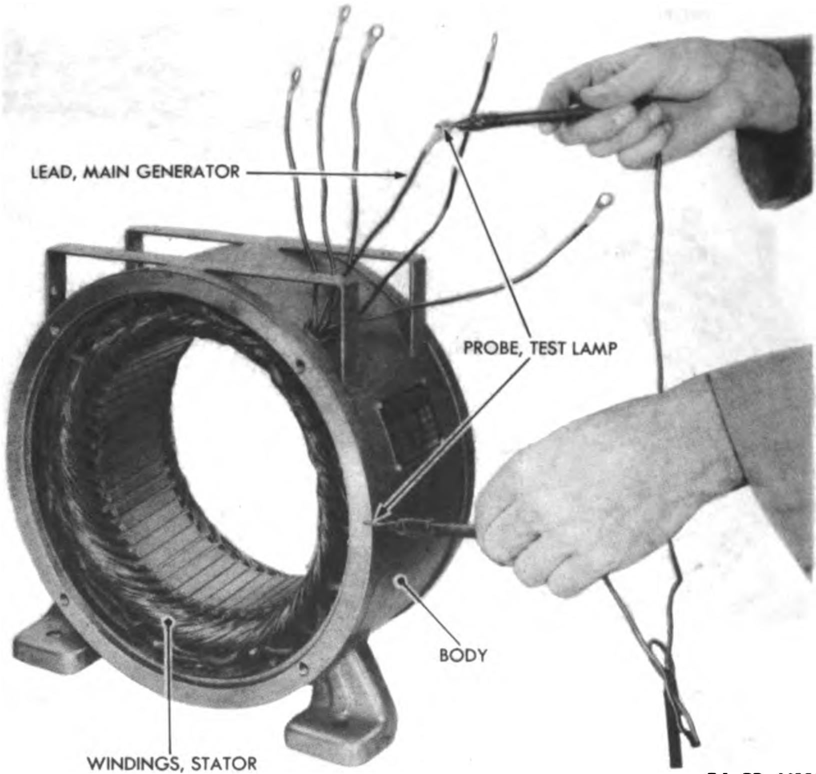


Figure 42 — Testing Stator Windings for Ground

(d) Inspect brushes to see if they are broken or worn. Measure length of each brush (scale). Any brush that is ¾ inch or less in length must be replaced.

(e) Examine threads of all screws and tapped threads in screw holes to see if they are burred or stripped.

(f) Inspect brush tension arm springs to see if they are broken or weak.

(g) Examine all insulator spacers and bushings to see if they are broken.

(h) Inspect all metal parts to see if they are bent, worn, or broken.

(5) INSPECT COUPLING END GENERATOR PARTS.

(a) Inspect driving flange to see if it is bent or broken. Observe keyway to see if it is square and free of burs. Examine threads of the sockethead setscrews and threads tapped in screw holes, to see

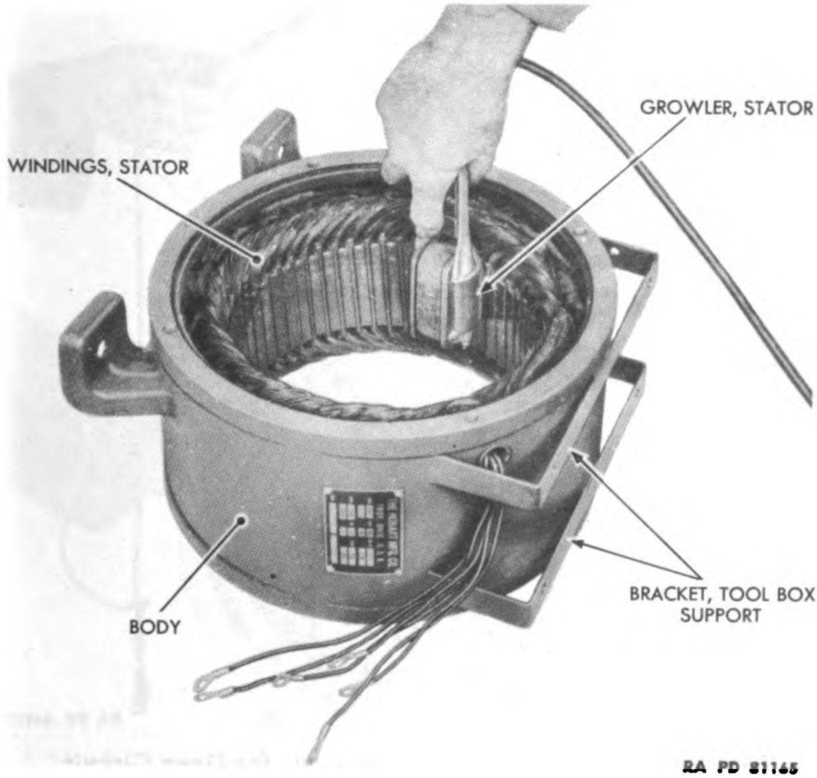


Figure 43 — Testing Stator Windings for Short Circuit

if they are burred or stripped. Examine welds to see if any have broken loose.

(b) Inspect armature shaft bearing bracket to see if it is broken. Examine threads in tapped screw holes and lubrication pipe nipple hole, to see if they are burred or stripped. Inspect lubrication pipe nipple, elbow, and grease cup to see if they are broken, bent, plugged, or have damaged threads.

(c) Inspect grease retainer to see if it is bent or if welds have broken loose. Examine felt washer to see if it is torn, worn, or grease-soaked. Inspect the gasket to see if it is torn.

(d) Examine fan cover to see if it is bent or broken.

(e) Examine all screws and lock washers to see if they are broken. Note whether or not screw threads are burred or stripped.

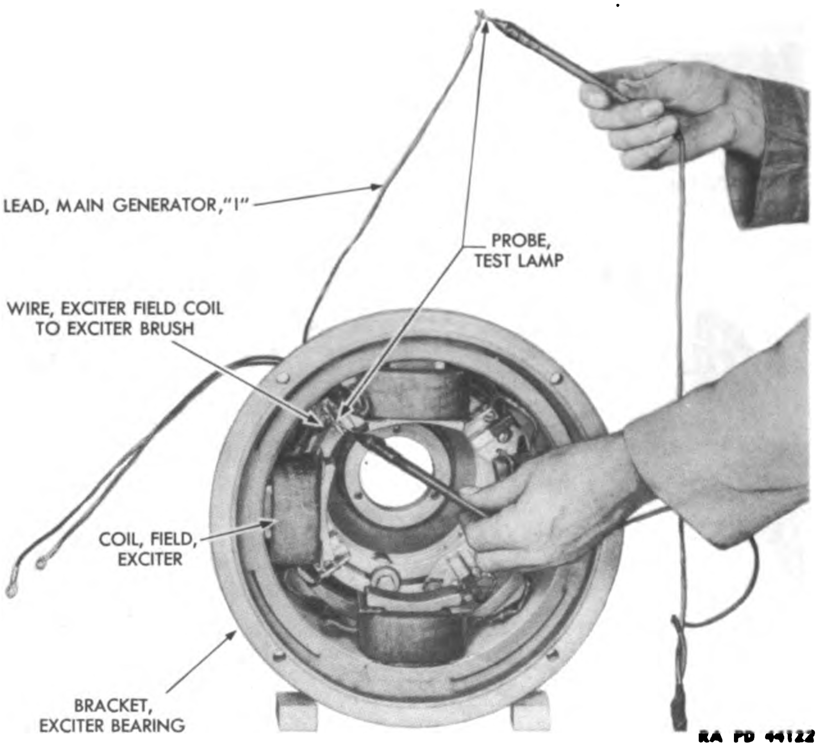


Figure 44 — Testing Exciter Field Coils for Open Circuit

26. MAINTENANCE AND REPAIRS.

a. Equipment.

DOLLY	PLIERS
EQUIPMENT, soldering	PULLER, gear
EQUIPMENT, welding	PAPER, flint, class B, No. 00
FILE, fine mill	SCALE ( )
GLYPTAL, No. 1209 black	SCREWDRIVER
HAMMER	TAP, thread, $^5/_{16}$-18 NC
LATHE	TAPE
LOOM	WIRE
MACHINE, undercutting	

b. Procedure.

(1) REPAIRS TO ROTOR ASSEMBLY.

(a) Revolving Field Coils.

EQUIPMENT, welding	PLIERS
GLYPTAL, No. 1209 black	SCALE, spring
LOOM	TAPE

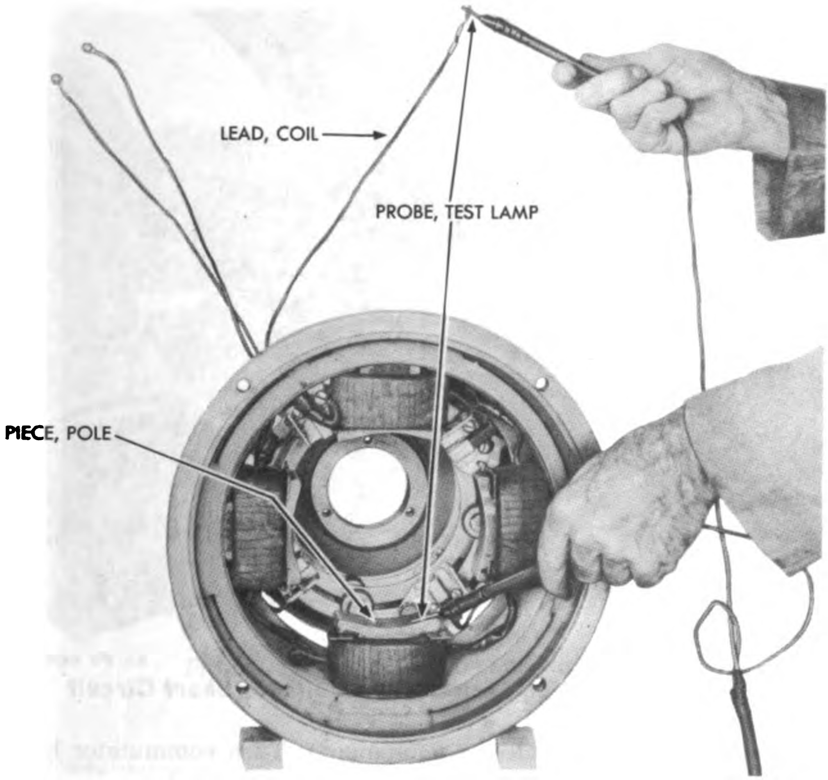


Figure 45 — Testing Exciter Field Coils for Ground

1. In case of an open circuit in a revolving field coil, replace coil. Weigh coil to be discarded and weigh the new coil (scales). Use a new coil having the same weight as the one removed to preserve rotor assembly balance. In case the open circuit is in a connection, peel back insulation on the wire. Twist wires together (pliers) and weld (welding equipment). Push loom over connection and wrap with tape. Paint tape with No. 1209 black glyptal.

2. In case a revolving field coil is grounded, replace coil and all insulators. If a connection is grounded, remove tape and loom. Install new loom and tape. Paint tape (No. 1209 black glyptal).

3. Replace short-circuited revolving field coils.

(b) Exciter Armature.

LATHE	UNDERCUTTER, armature, mica, w/saw blade
SOLDERING EQUIPMENT	

1. Examine exciter armature if it has an open circuit. If open circuit is caused by a wire pulled loose from a commutator bar, solder

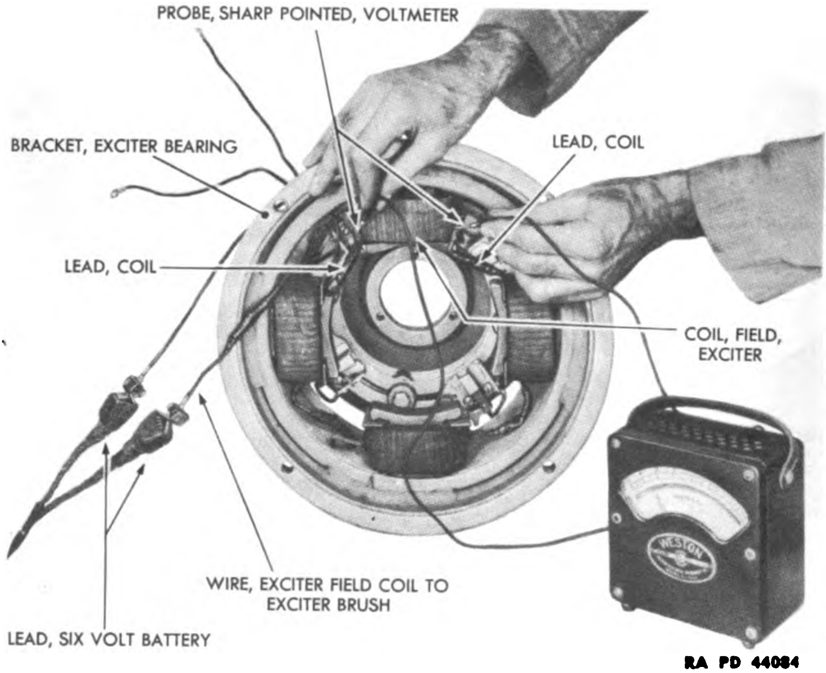


Figure 46 — Testing Exciter Field Coils for Short Circuit

wire into slot in bar (soldering equipment). Turn commutator bars down on a lathe and undercut the mica (substep (c) below). If break cannot be located, replace armature.

2. If exciter armature is grounded or short-circuited, replace.

(c) Commutator Bars.

LATHE	PAPER, flint, class B, No. 00
MACHINE, undercutting	

If commutator bars are scored, place armature assembly in a lathe (fig. 47). Take a cut from commutator bars. Make the cut as light as possible, but deep enough to remove all score marks. Hold a piece of No. 00 flint paper against the revolving commutator bars to remove cutting tool marks. Remove armature from lathe. Then undercut mica to a depth of 0.025 inch between commutator bars (undercutting machine) (fig. 48).

(d) Slip Rings and Slip Ring Separator.

HAMMER	SOLDERING EQUIPMENT
LATHE	TAP, thread, $\frac{5}{16}$-18 NC
PAPER, flint, class B, No. 00	UNDERCUTTER, armature, mica, w/saw blade
PULLER, gear	WELDING EQUIPMENT
SCREWDRIVER	

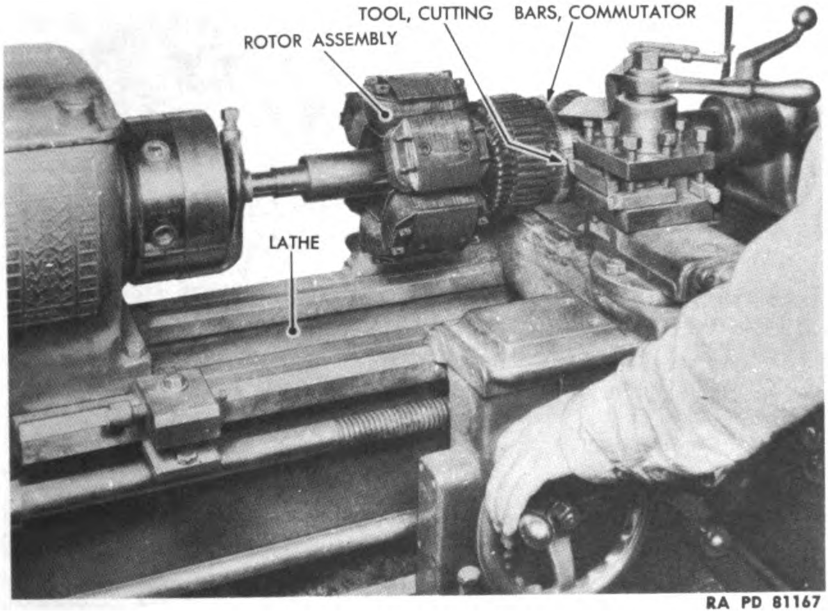


Figure 47 — Cutting Commutator Bars

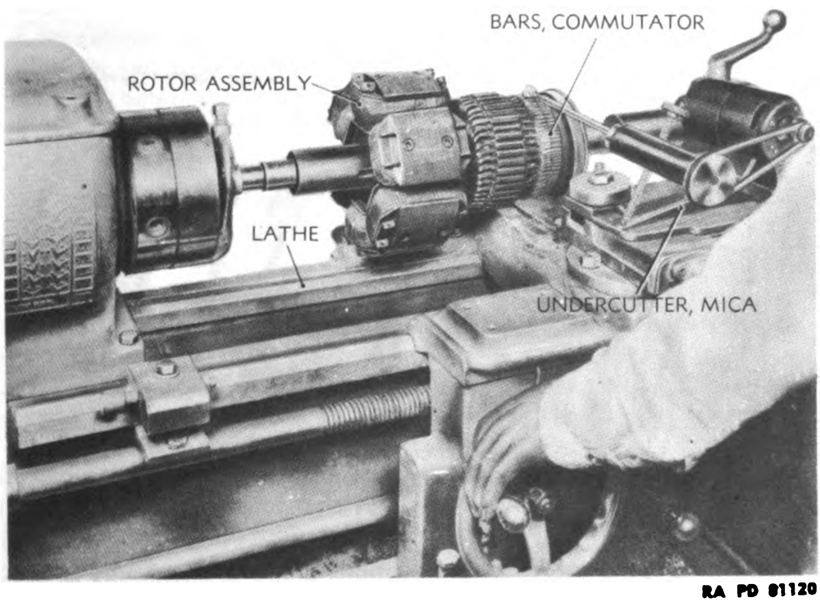


Figure 48 — Undercutting Mica Between Commutator Bars

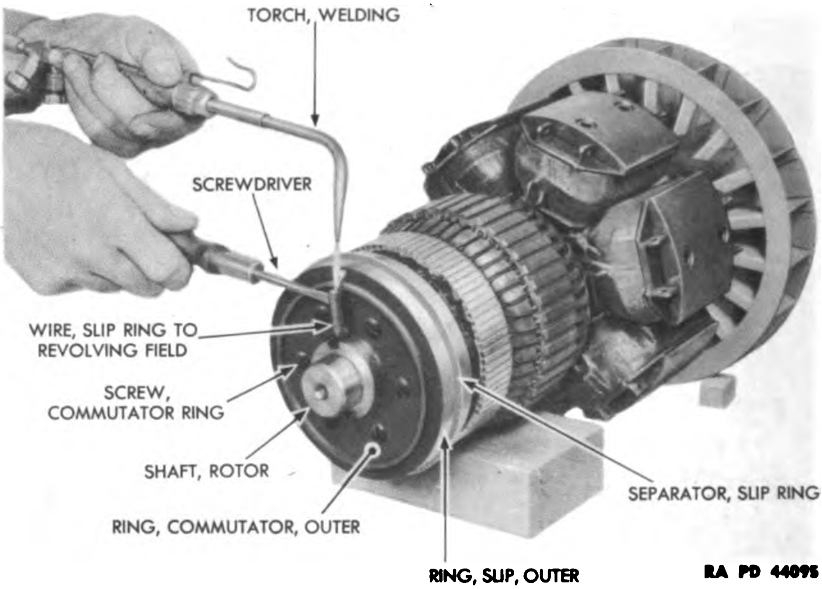


Figure 49 — Removing Slip Ring Assembly

1. If the slip rings are scored, place armature in lathe. Take a cut off each slip ring. Remove only enough metal to eliminate the score marks. Hold a piece of No. 00 flint paper against the revolving slip rings to remove cutting tool marks.

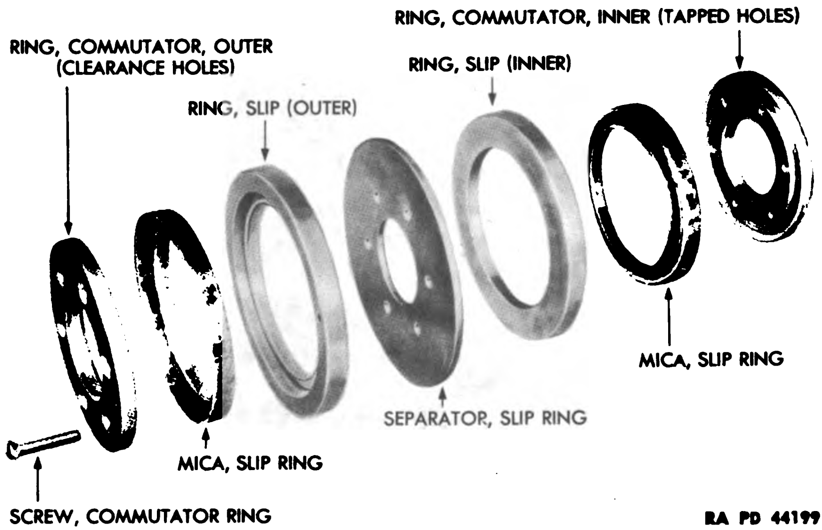


Figure 50 — Slip Ring Assembly — Exploded View

2. If the slip ring separator is broken, melt the solder which secures the revolving field wire to outer slip ring, and pry wire from slip ring (welding equipment and screwdriver) (fig. 49). Remove the six commutator ring screws (screwdriver) (fig. 49). Tap threads in two screw holes in the commutator ring on opposite sides of shaft ($^5/_{16}$-18 NC thread tap). Using a gear puller, pull the commutator outer ring from shaft (fig. 49). Lift slip ring and mica ring from shaft (fig. 50). Lift slip ring separator from shaft (fig. 50). Place a new slip ring separator in position on shaft. Place slip ring in position on the commutator ring with the mica in position between the two parts. Start assembly on shaft. Be sure screw holes line up. Tap commutator ring carefully on shaft (hammer). Install six commutator ring screws (screwdriver). Solder revolving field wire to outer slip ring (soldering equipment) (fig. 49).

(e) Generator Bearings.

FILE, fine mill

Replace armature shaft bearings if worn or broken. If shaft is scored due to bearing failure, smooth off ridges (fine mill file). Do not attempt to eliminate score marks. Smooth it just enough so bearing can be pressed on. In case shaft is damaged enough to be undersize, replace armature assembly.

(f) Fan.

DOLLY	WELDING EQUIPMENT
HAMMER	

1. Straighten fan if bent (hammer and dolly). If welds have broken loose, weld fan to armature shaft (welding equipment). Be careful to preserve balance by using a very small amount of welding metal. Spot welds evenly around circumference of shaft.

(2) REPAIRS TO BODY AND STATOR ASSEMBLY (fig. 30).

(a) Stator Windings.

GLYPTAL, No. 1209 black	TAPE
LOOM	WELDING EQUIPMENT

1. If stator windings have an open circuit, it may be due to a loose connection. The coils themselves are composed of three wires connected in parallel. It is highly improbable that all three wires in one coil would break simultaneously. If an open circuit is indicated in the stator, remove tape and loom from the connection which appears at fault. Examine welds. When the faulty connection is found, weld wires together (welding equipment). Cover all exposed connections with loom and tape. Paint tape (No. 1209 black glyptal). If the open circuit is within a coil, replace stator.

2. If stator windings are grounded, inspect all connections and lead wires for faulty insulation. Remove faulty insulation. Install loom and tape on the bared wire. Paint tape (No. 1209 black glyptal).

If ground cannot be located, it is probably in a coil and it will be necessary to replace body with stator.

3. If stator windings are short-circuited, replace body with stator.

(b) Body and Tool Box Support Bracket.

DOLLY
HAMMER
TAP, thread
WELDING EQUIPMENT

1. Weld tool box support bracket if broken (welding equipment); straighten if bent (hammer and dolly).

2. Repair damaged screw hole threads in body by running a thread tap through them.

(3) REPAIRS TO EXCITER BEARING BRACKET ASSEMBLY.

(a) Exciter Field Coils.

Replace any exciter field coil having an open circuit, ground, or short circuit.

(b) Brushes.

Replace brushes if broken or worn to less than ¾ inch in length.

(c) Brush Tension Arm Springs.

Replace brush tension arm springs if they are broken or weak. Correct tension is 8 ounces for slip ring brushes and 12 ounces for exciter brushes (par. 27 **g** (4) (**m**)).

(d) Metal Parts.

DOLLY
HAMMER
TAP, thread

Repair burred screw holes by running a thread tap through them. Straighten bent metal parts (hammer and dolly). Replace broken metal parts.

(e) Insulator Spacers and Bushing.

Replace all broken or doubtful insulator spacers and bushings.

(4) REPAIRS TO COUPLING AND GENERATOR PARTS.

(a) Driving Flange.

FILE, fine mill
TAP, thread
WELDING EQUIPMENT

Replace driving flange if it is bent, broken, or if the keyway is worn on edges. Reweld any welds that have broken loose (welding equipment). Remove burs from keyway (fine mill file). Remove burs from tapped screw holes by running thread tap through the threads.

(b) Armature Shaft Bearing Bracket.

TAP, thread
WIRE

Replace armature shaft bearing bracket if broken. Repair damaged threads by running a thread tap through them. Replace damaged

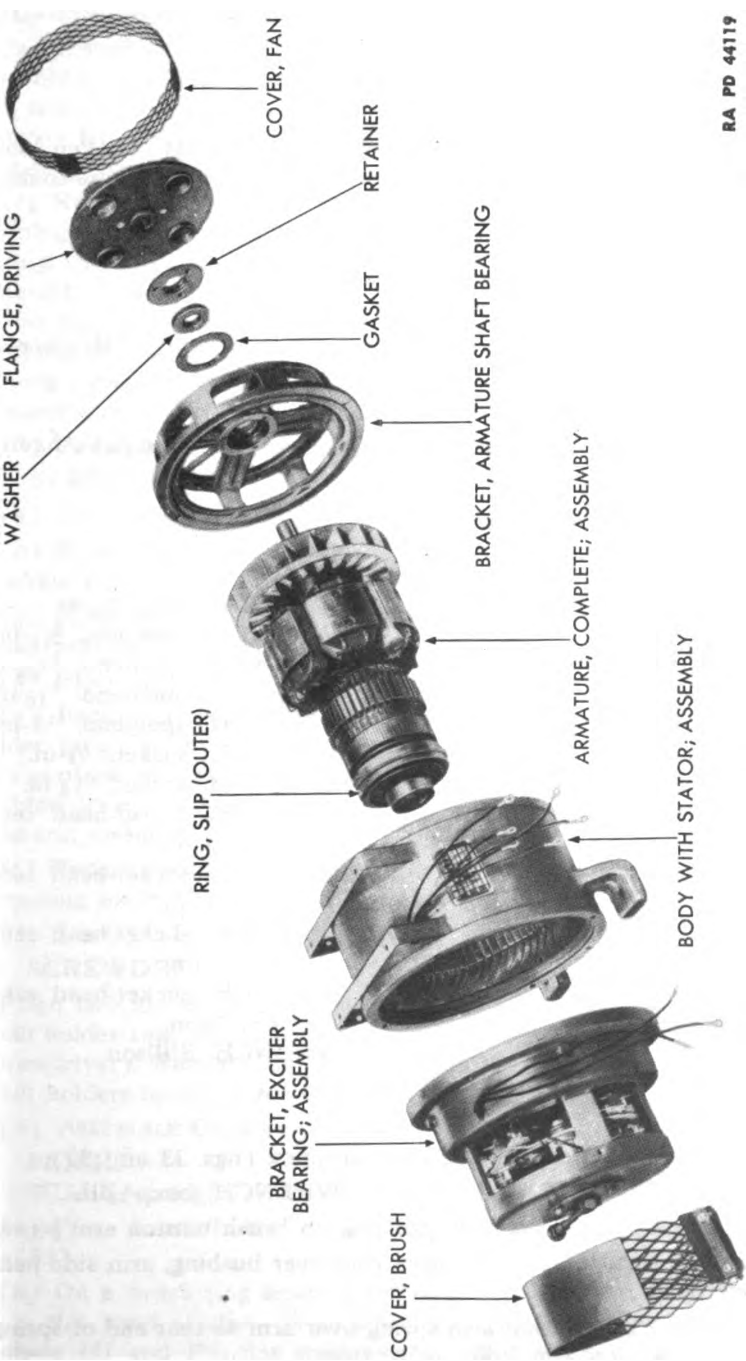


Figure 51 — Main Generator Assembly

If ground cannot be located, it is probably in a coil and it will be necessary to replace body with stator.

3. If stator windings are short-circuited, replace body with stator.

(b) Body and Tool Box Support Bracket.

DOLLY
HAMMER
TAP, thread
WELDING EQUIPMENT

1. Weld tool box support bracket if broken (welding equipment); straighten if bent (hammer and dolly).

2. Repair damaged screw hole threads in body by running a thread tap through them.

(3) REPAIRS TO EXCITER BEARING BRACKET ASSEMBLY.

(a) Exciter Field Coils.

Replace any exciter field coil having an open circuit, ground, or short circuit.

(b) Brushes.

Replace brushes if broken or worn to less than ¾ inch in length.

(c) Brush Tension Arm Springs.

Replace brush tension arm springs if they are broken or weak. Correct tension is 8 ounces for slip ring brushes and 12 ounces for exciter brushes (par. 27 g (4) (m)).

(d) Metal Parts.

DOLLY
HAMMER
TAP, thread

Repair burred screw holes by running a thread tap through them. Straighten bent metal parts (hammer and dolly). Replace broken metal parts.

(e) Insulator Spacers and Bushing.

Replace all broken or doubtful insulator spacers and bushings.

(4) REPAIRS TO COUPLING AND GENERATOR PARTS.

(a) Driving Flange.

FILE, fine mill
TAP, thread
WELDING EQUIPMENT

Replace driving flange if it is bent, broken, or if the keyway is worn on edges. Reweld any welds that have broken loose (welding equipment). Remove burs from keyway (fine mill file). Remove burs from tapped screw holes by running thread tap through the threads.

(b) Armature Shaft Bearing Bracket.

TAP, thread
WIRE

Replace armature shaft bearing bracket if broken. Repair damaged threads by running a thread tap through them. Replace damaged

MAIN GENERATOR AND EXCITER

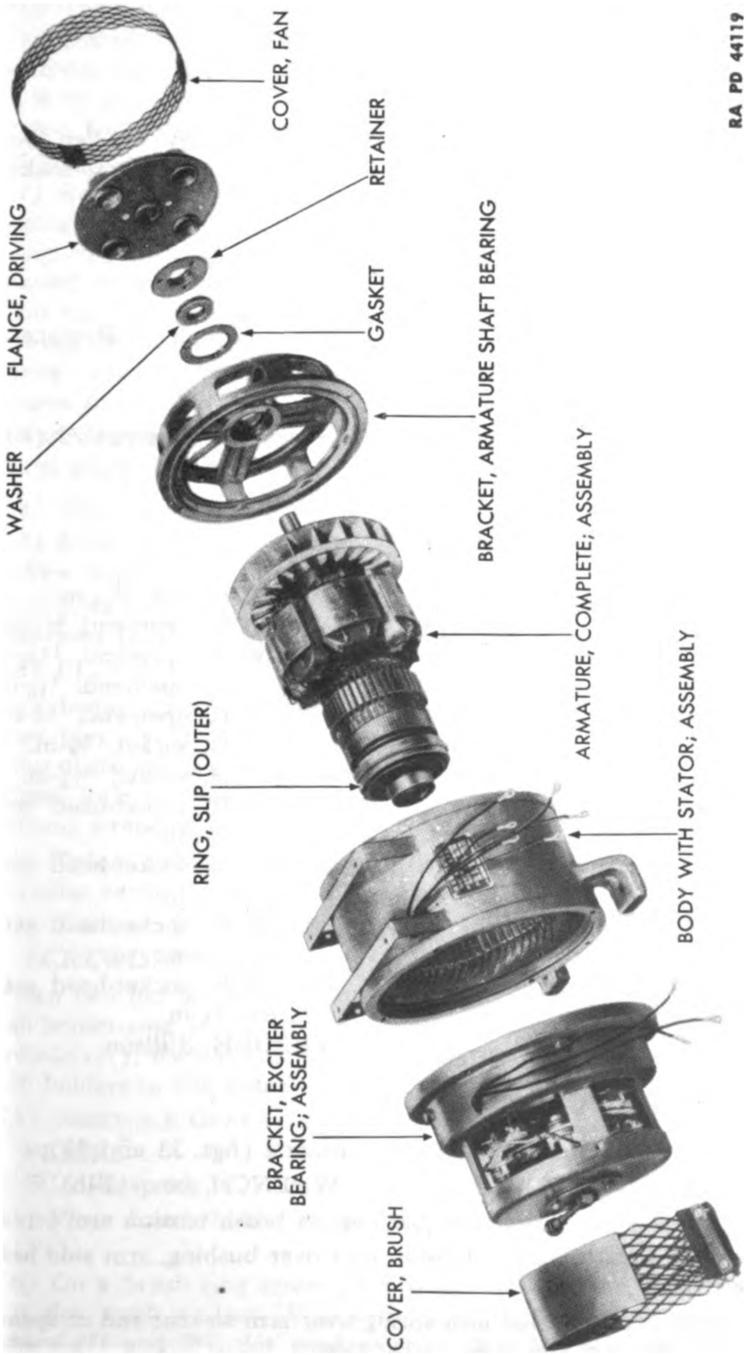


Figure 51 — Main Generator Assembly

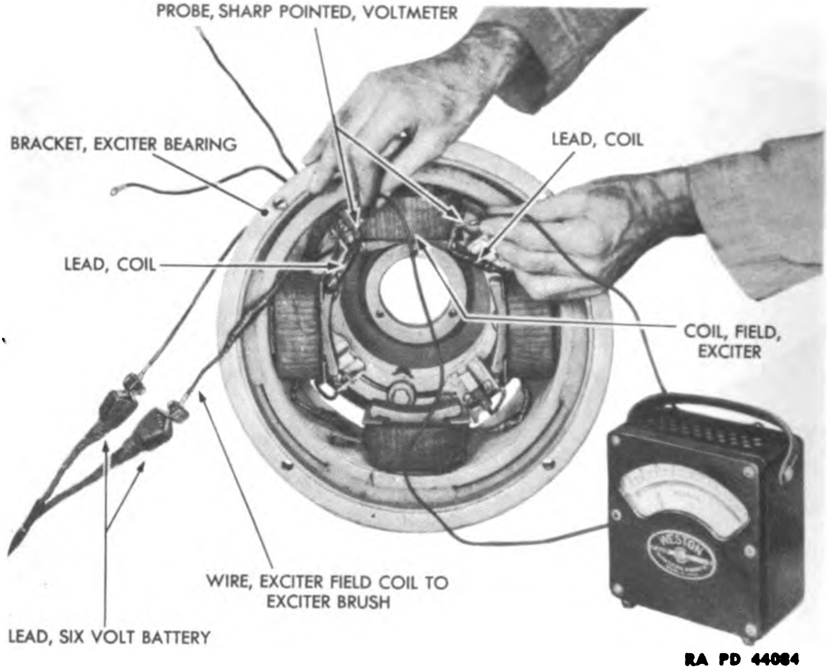


Figure 46 — Testing Exciter Field Coils for Short Circuit

wire into slot in bar (soldering equipment). Turn commutator bars down on a lathe and undercut the mica (substep (c) below). If break cannot be located, replace armature.

2. If exciter armature is grounded or short-circuited, replace.

(c) Commutator Bars.

LATHE	PAPER, flint, class B, No. 00
MACHINE, undercutting	

If commutator bars are scored, place armature assembly in a lathe (fig. 47). Take a cut from commutator bars. Make the cut as light as possible, but deep enough to remove all score marks. Hold a piece of No. 00 flint paper against the revolving commutator bars to remove cutting tool marks. Remove armature from lathe. Then undercut mica to a depth of 0.025 inch between commutator bars (undercutting machine) (fig. 48).

(d) Slip Rings and Slip Ring Separator.

HAMMER	SOLDERING EQUIPMENT
LATHE	TAP, thread, $\frac{5}{16}$-18 NC
PAPER, flint, class B, No. 00	UNDERCUTTER, armature, mica, w/saw blade
PULLER, gear	WELDING EQUIPMENT
SCREWDRIVER	

MAIN GENERATOR AND EXCITER

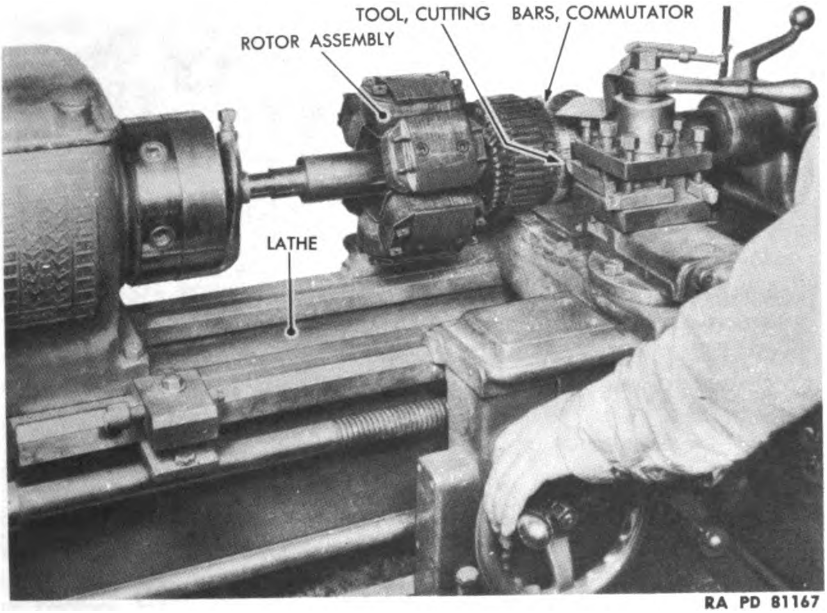


Figure 47 — Cutting Commutator Bars

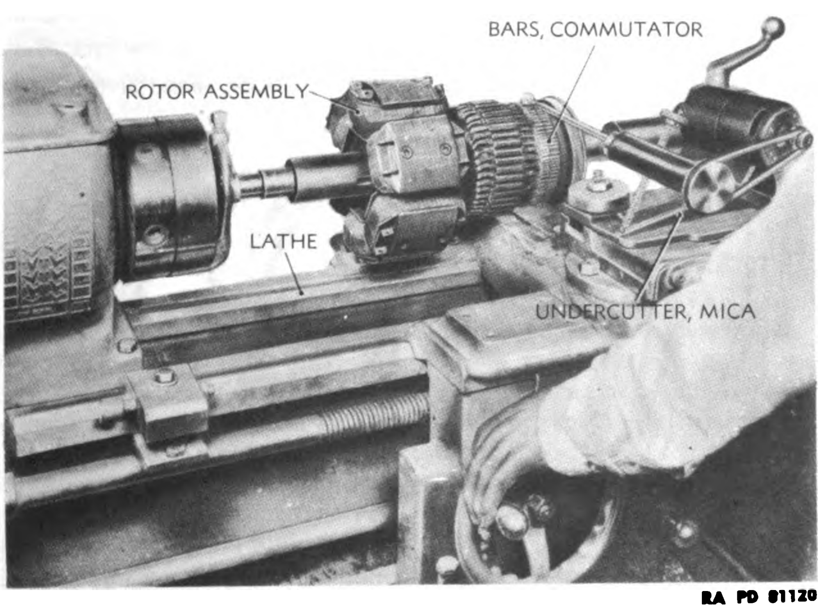


Figure 48 — Undercutting Mica Between Commutator Bars

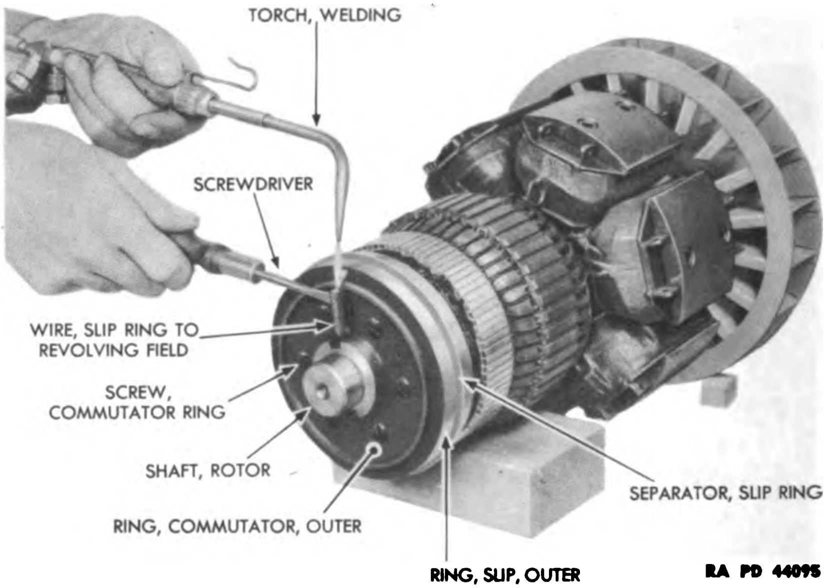


Figure 49 — Removing Slip Ring Assembly

1. If the slip rings are scored, place armature in lathe. Take a cut off each slip ring. Remove only enough metal to eliminate the score marks. Hold a piece of No. 00 flint paper against the revolving slip rings to remove cutting tool marks.

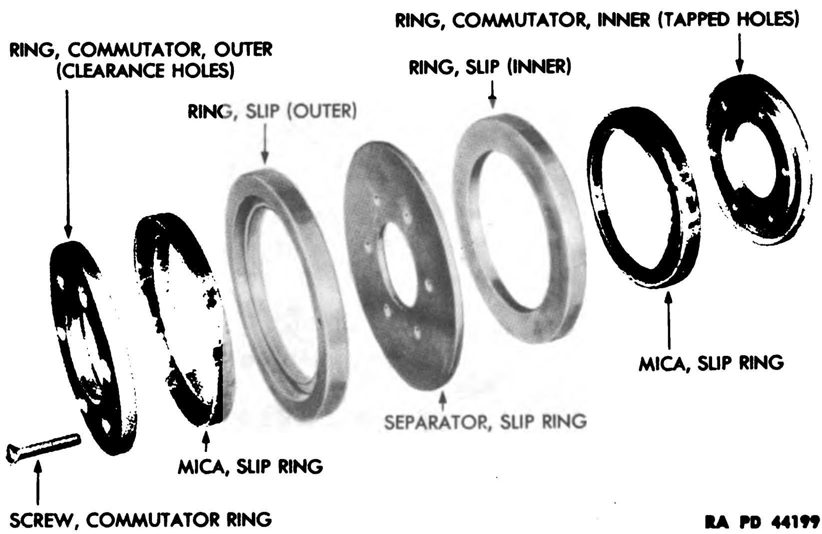


Figure 50 — Slip Ring Assembly — Exploded View

MAIN GENERATOR AND EXCITER

2. If the slip ring separator is broken, melt the solder which secures the revolving field wire to outer slip ring, and pry wire from slip ring (welding equipment and screwdriver) (fig. 49). Remove the six commutator ring screws (screwdriver) (fig. 49). Tap threads in two screw holes in the commutator ring on opposite sides of shaft ($5/16$-18 NC thread tap). Using a gear puller, pull the commutator outer ring from shaft (fig. 49). Lift slip ring and mica ring from shaft (fig. 50). Lift slip ring separator from shaft (fig. 50). Place a new slip ring separator in position on shaft. Place slip ring in position on the commutator ring with the mica in position between the two parts. Start assembly on shaft. Be sure screw holes line up. Tap commutator ring carefully on shaft (hammer). Install six commutator ring screws (screwdriver). Solder revolving field wire to outer slip ring (soldering equipment) (fig. 49).

(e) Generator Bearings.

FILE, fine mill

Replace armature shaft bearings if worn or broken. If shaft is scored due to bearing failure, smooth off ridges (fine mill file). Do not attempt to eliminate score marks. Smooth it just enough so bearing can be pressed on. In case shaft is damaged enough to be undersize, replace armature assembly.

(f) Fan.

DOLLY — WELDING EQUIPMENT
HAMMER

1. Straighten fan if bent (hammer and dolly). If welds have broken loose, weld fan to armature shaft (welding equipment). Be careful to preserve balance by using a very small amount of welding metal. Spot welds evenly around circumference of shaft.

(2) REPAIRS TO BODY AND STATOR ASSEMBLY (fig. 30).

(a) Stator Windings.

GLYPTAL, No. 1209 black — TAPE
LOOM — WELDING EQUIPMENT

1. If stator windings have an open circuit, it may be due to a loose connection. The coils themselves are composed of three wires connected in parallel. It is highly improbable that all three wires in one coil would break simultaneously. If an open circuit is indicated in the stator, remove tape and loom from the connection which appears at fault. Examine welds. When the faulty connection is found, weld wires together (welding equipment). Cover all exposed connections with loom and tape. Paint tape (No. 1209 black glyptal). If the open circuit is within a coil, replace stator.

2. If stator windings are grounded, inspect all connections and lead wires for faulty insulation. Remove faulty insulation. Install loom and tape on the bared wire. Paint tape (No. 1209 black glyptal).

If ground cannot be located, it is probably in a coil and it will be necessary to replace body with stator.

3. If stator windings are short-circuited, replace body with stator.

(b) Body and Tool Box Support Bracket.

DOLLY
HAMMER
TAP, thread
WELDING EQUIPMENT

1. Weld tool box support bracket if broken (welding equipment); straighten if bent (hammer and dolly).

2. Repair damaged screw hole threads in body by running a thread tap through them.

(3) REPAIRS TO EXCITER BEARING BRACKET ASSEMBLY.

(a) Exciter Field Coils.

Replace any exciter field coil having an open circuit, ground, or short circuit.

(b) Brushes.

Replace brushes if broken or worn to less than ¾ inch in length.

(c) Brush Tension Arm Springs.

Replace brush tension arm springs if they are broken or weak. Correct tension is 8 ounces for slip ring brushes and 12 ounces for exciter brushes (par. 27 g (4) (m)).

(d) Metal Parts.

DOLLY
HAMMER
TAP, thread

Repair burred screw holes by running a thread tap through them. Straighten bent metal parts (hammer and dolly). Replace broken metal parts.

(e) Insulator Spacers and Bushing.

Replace all broken or doubtful insulator spacers and bushings.

(4) REPAIRS TO COUPLING AND GENERATOR PARTS.

(a) Driving Flange.

FILE, fine mill
TAP, thread
WELDING EQUIPMENT

Replace driving flange if it is bent, broken, or if the keyway is worn on edges. Reweld any welds that have broken loose (welding equipment). Remove burs from keyway (fine mill file). Remove burs from tapped screw holes by running thread tap through the threads.

(b) Armature Shaft Bearing Bracket.

TAP, thread
WIRE

Replace armature shaft bearing bracket if broken. Repair damaged threads by running a thread tap through them. Replace damaged

MAIN GENERATOR AND EXCITER

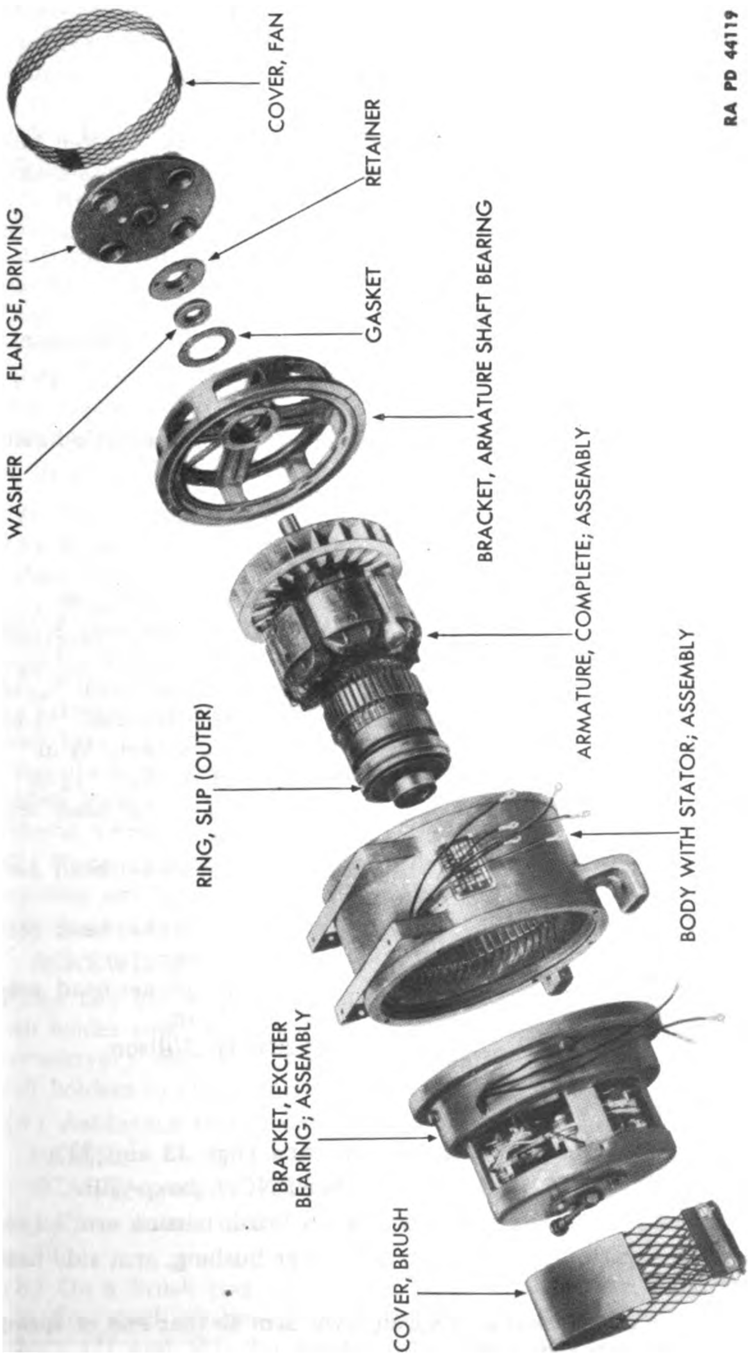


Figure 51 — Main Generator Assembly

lubrication pipe nipple, elbow, and grease cup. Clean obstructed lubrication ports by running wire through them.

(c) Grease Retainer.

WELDING EQUIPMENT

Replace grease retainer if bent. Weld if welds have broken loose (welding equipment). Replace felt washer if worn or grease-soaked. Replace gasket if torn.

(d) Fan Cover.

DOLLY
HAMMER

Straighten fan cover if bent (hammer and dolly). Replace if broken.

(e) Screws and Lock Washers.

Replace broken lock washers and screws. Replace screws having damaged threads.

27. ASSEMBLY.

a. Equipment.

BATTERY, dry cell (1½-volt)
COMPASS, magnetic
FILE
GLYPTAL, No. 1209 black
HAMMER
HAMMER, soft
LOOM
PILOT, hollow steel
PLIERS
PRESS, arbor
PUNCH, center
SCALE, spring
SCREWDRIVER
TAPE
WELDING EQUIPMENT
WRENCH, box, ⅜-in.
WRENCH, box, 9/16-in.
WRENCH, open-end, 5/16-in.
WRENCH, open-end, 11/32-in.
WRENCH, open-end, 7/16-in.
WRENCH, open-end, ½-in.
WRENCH, socket, ½-in.
WRENCH, socket, 9/16-in.
WRENCH, socket-head set-screw, 9/64-in.
WRENCH, socket-head set-screw, 5/16-in.
WRENCH, socket-head set-screw, ⅜-in.
WRENCH, socket-head set-screw, ⅝-in.
WRENCH, Stillson

b. Procedure.

(1) ASSEMBLE SLIP RING BRUSH HOLDER (figs. 33 and 52).

SCREWDRIVER
WRENCH, box, ⅜-in.

(a) Slide brush tension arm bushing on brush tension arm screw.

(b) Slide slip ring brush tension arm over bushing, arm side next to screw head.

(c) Slide brush tension arm spring over arm so that end of spring hooks over tension arm from spring side.

MAIN GENERATOR AND EXCITER

(d) Place spring adjusting holder on end of spring.

(e) Install screw into slip ring brush holder so that spring adjusting holder tang fits into tang hole in brush holder, and brush tension arm is on top of brush holder. Tighten screw securely (screwdriver). Tighten lock nut securely on end of tension arm screw ($^{11}/_{32}$-in. open-end wrench).

(f) Repeat substeps *(a)* through *(e)* above to assemble the remaining three slip ring brush tension arms, springs, and bushings to slip ring brush holder. NOTE: If new brush holders are being installed, it is necessary to tap threads in brush wire screw holes at this time. Hold brush holder with pliers at screw hole to prevent breaking. Screw a No. 6-32 by $^{3}/_{16}$-inch Parker-Kalon type "2" self-tapping screw or equivalent into the screw hole (screwdriver). Remove screw.

(2) ASSEMBLE EXCITER BRUSH HOLDERS (fig. 52).

SCREWDRIVER	WRENCH, open-end, $^{11}/_{32}$-in.

(a) Slide brush tension arm bushing on brush tension arm screw.

(b) Slide exciter brush tension arm over bushing, arm side next to screw head.

(c) Slide brush tension arm spring over arm so that end of spring hooks over tension arm from spring side.

(d) Place spring adjusting holder on end of spring.

(e) Install screw into exciter brush plate so that spring adjusting holder tang fits into tang hole in holder and brush tension arm is on top of exciter brush plate. Tighten screw securely (screwdriver). Tighten lock nut securely on end of tension arm screw ($^{11}/_{32}$-in. open-end wrench).

(f) Repeat substeps *(a)* through *(e)* above to assemble the three remaining exciter brush holders.

(3) INSTALL EXCITER BRUSH HOLDERS (fig. 52).

SCREWDRIVER

Place two exciter brush holders in position on the inner exciter brush holder ring and secure each with two screws and lock washers (screwdriver). Repeat this step to install the two remaining exciter brush holders to the outer exciter brush holder ring.

(4) ASSEMBLE GENERATOR BRUSH RING (fig. 52).

PLIERS	SCREWDRIVER
SCALE, spring	WRENCH, box, $^{9}/_{16}$-in.

(a) Place brush holder mount flat on bench, beveled side up (fig. 52).

(b) On a brush ring screw (X), place, respectively, lock washer (W); flat steel washer (V); short fiber bushing (Q); two fiber washers (U and P); flat steel washer (N); $^{37}/_{64}$-inch steel spacer

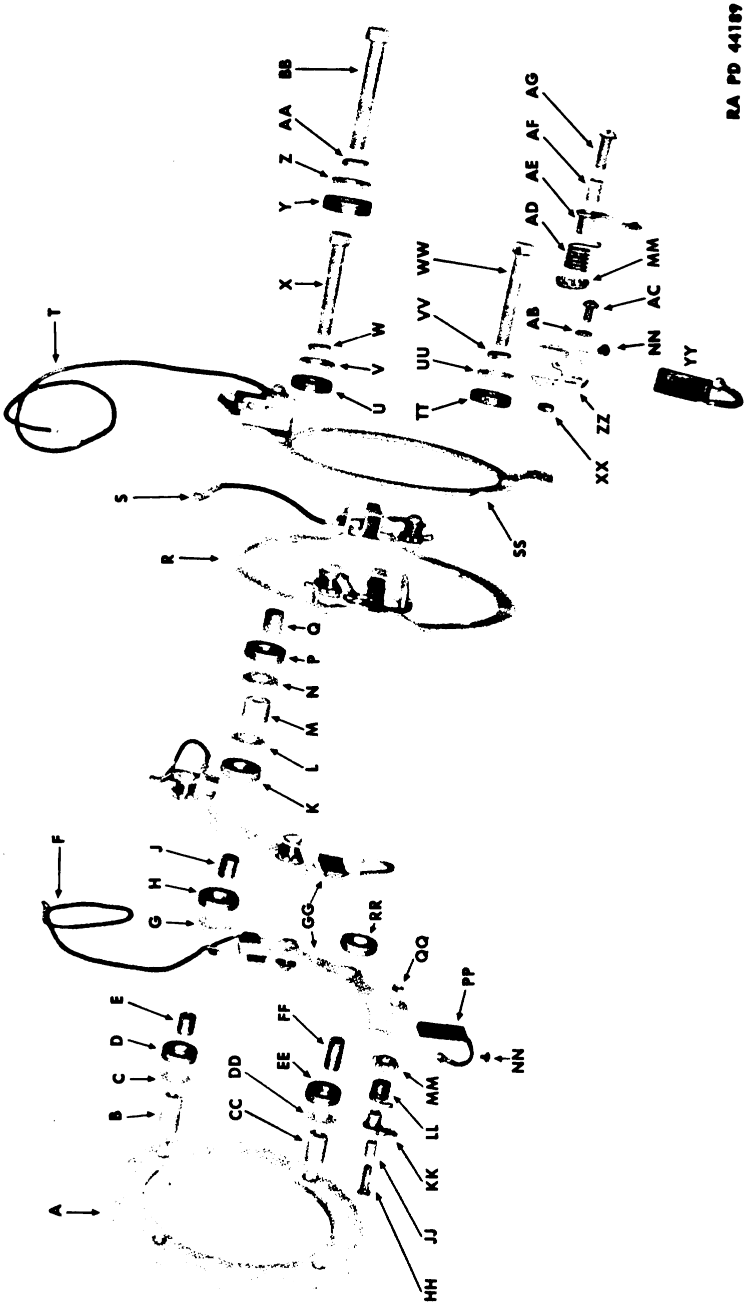


Figure 52 — Generator Brush Ring Assembly — Exploded View

A — MOUNT, BRUSH HOLDER
B — SPACER (1-23/64-IN., STEEL)
C — WASHER, STEEL, FLAT
D — WASHER, FIBER
E — BUSHING, BRUSH HOLDER
F — LEAD TO FIELD RHEOSTAT OR TIME DELAY RELAY
G — WASHER, FLAT, STEEL
H — WASHER, FIBER
J — BUSHING, BRUSH HOLDER
K — WASHER, FIBER
L — WASHER, FLAT, STEEL
M — SPACER (37/64-IN., STEEL)
N — WASHER, STEEL, FLAT
P — WASHER, FIBER
Q — BUSHING, BRUSH HOLDER
R — RING, HOLDER, EXCITER BRUSH (OUTER)
S — WIRE, EXCITER BRUSH HOLDER TO SLIP RING BRUSH HOLDER
T — LEAD, TO FIELD RHEOSTAT OR TIME DELAY RELAY
U — WASHER, FIBER
V — WASHER, FLAT, STEEL
W — WASHER, LOCK
X — SCREW, BRUSH RING
Y — WASHER, FIBER
Z — WASHER, FLAT, STEEL
AA — WASHER, LOCK
BB — SCREW, BRUSH RING
CC — SPACER (63/64-IN., STEEL)
DD — WASHER, FLAT, STEEL
EE — WASHER, FIBER
FF — BUSHING, BRUSH HOLDER
GG — HOLDER, SLIP RING BRUSH
HH — SCREW, TENSION ARM
JJ — BUSHING, BRUSH TENSION ARM
KK — ARM, BRUSH TENSION
LL — SPRING, BRUSH TENSION ARM
MM — HOLDER, SPRING ADJUSTING
NN — SCREW, BRUSH PIG TAIL
PP — BRUSH, SLIP RING
QQ — NUT, LOCK, TENSION ARM SCREW
RR — WASHER, FIBER
SS — RING, HOLDER, EXCITER BRUSH (INNER)
TT — WASHER, FIBER
UU — WASHER, FLAT, STEEL
VV — WASHER, LOCK
WW — SCREW, BRUSH RING
XX — NUT, LOCK, TENSION ARM SCREW
YY — BRUSH, EXCITER
ZZ — PLATE, EXCITER BRUSH
AB — WASHER, LOCK BRUSH, PLATE TO RING SCREW
AC — SCREW, BRUSH PLATE TO RING
AD — SPRING, BRUSH TENSION ARM
AE — ARM, BRUSH TENSION
AF — BUSHING, BRUSH TENSION ARM
AG — SCREW, BRUSH TENSION ARM

RA PD 44189B

Legend for Figure 52 — Generator Brush Ring Assembly — Exploded View

(M); flat steel washer (L); brush holder bushing (J); and fiber washer (K). Now insert screw through its hole in the slip ring brush holder (GG), plain side of brush holder away from head of screw. Then place a fiber washer (H) and flat steel washer (G) on the screw. Start screw into a screw hole in brush holder mount.

(c) On another brush ring screw (WW), place, in order given, lock washer (VV); flat steel washer (UU); long fiber bushing (FF); fiber washers (TT and RR); slip ring brush holder (GG) (plain side toward head of screw); fiber washer (EE); flat steel washer (DD); and 63/64-inch steel spacer (CC). Start screw (WW) into the screw hole in brush holder mount (A) opposite the screw hole into which screw (X) was installed in step *(b)*.

(d) With the brush holder mount still flat on bench, carefully remove the screw installed in substep *(b)* above, with lock washer (W), flat steel washer (V) and top fiber washer (U) on screw. This leaves a fiber bushing (Q), fiber washer (P), steel washer (N), steel spacer (M), steel washer (L), fiber washer (K), and fiber bushing (J) in place over the brush holder.

(e) Hook outer exciter brush ring (R) over brush ring screw (WW) installed in substep *(c)* above (brush holder to left of screw). Be sure to place the ring (R) between the two top fiber washers (TT and RR) on screw (WW). Rest other side of ring on fiber washer (P) in place over screw hole on opposite side of brush holder mount (A).

(f) Insert inner exciter brush ring (SS) between two top fiber washers (TT and RR) on outer exciter brush ring (R) in place on brush holder mount (A). Place it so that brush plates on inner ring are on top, and one quarter the circumference away from the brush plates on the outer brush ring (R). Rest the other side of ring on fiber washer (P) in place over screw hole on opposite side of brush holder mount (A) (fig. 52).

(g) Insert screw (X) with lock washer (W), flat steel washer (V), and fiber washer (U) which were removed in substep *(d)* above, between the inner and outer brush rings (SS and R) through fiber bushing (Q), fiber washer (P), steel washer (N), steel spacer (M), steel washer (L), fiber bushing (J), fiber washer (K), brush holder (GG), fiber washer (H) and steel washer (G) in place on brush holder mount. Tighten screw (9/16-in. box wrench) (fig. 52).

(h) On another brush ring screw (BB), place a lock washer (AA), steel washer (Z), short fiber bushing (E), and a fiber washer (Y). Place screw (BB) between the two brush rings (R and SS). On end of the screw (BB), place a fiber washer (D), steel washer (C), and long steel spacer (B). Tighten screw into brush holder mount (A) (9/16-in. box wrench) (fig. 52).

(i) Repeat step *(h)* above to install remaining brush ring screw.

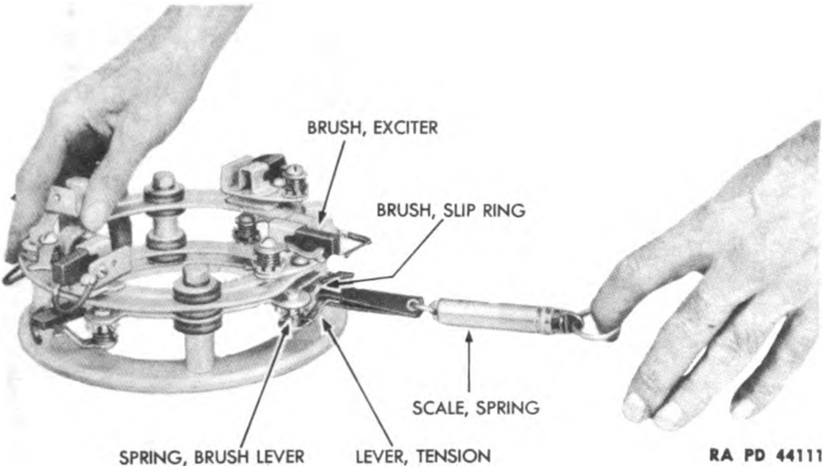


Figure 53 — Measuring Brush Spring Tension

(j) Tighten brush ring screw (WW) installed in step *(c)* above ($^9/_{16}$-in. box wrench).

(k) Place an exciter brush (YY) in each of the four brush plates (ZZ), with wires next to brush ring (R). Place tension arm (AE) against side of each brush (YY) near top of brush, so that the brush is held up in the plate (ZZ). Connect wires to screw (AC) in outer hole on brush holder plates (ZZ) (screwdriver) (fig. 33).

(l) Place a slip ring brush (PP) in each slip ring brush plate, with wires next to screw holes. Place brush tension arm (KK) against side of brush (PP) near top so that brush is held up in plate. Attach wires to screw in brush plate (screwdriver).

(m) Measure tension of brushes with a spring scale. Hook scale to end of brush tension arm. Pull scale and observe reading (fig. 53). Move end of brush tension arm spring to right or left to decrease or increase tension. Correct tension is 8 ounces for slip ring brushes, and 12 ounces for exciter brushes.

(n) Looking at the brush ring assembly from the side assembled in step *(c)* above, connect wire from exciter brush plate to the slip ring brush holder which is closest to mount (screwdriver) (fig. 33).

(o) Connect an 18-inch, unmarked main generator lead to slip ring brush holder assembled in step *(c)* above (screwdriver) (fig. 33).

(p) Connect a 22-inch, unmarked main generator lead to the exciter brush plate to the right of the one referred to in step *(n)* above (screwdriver).

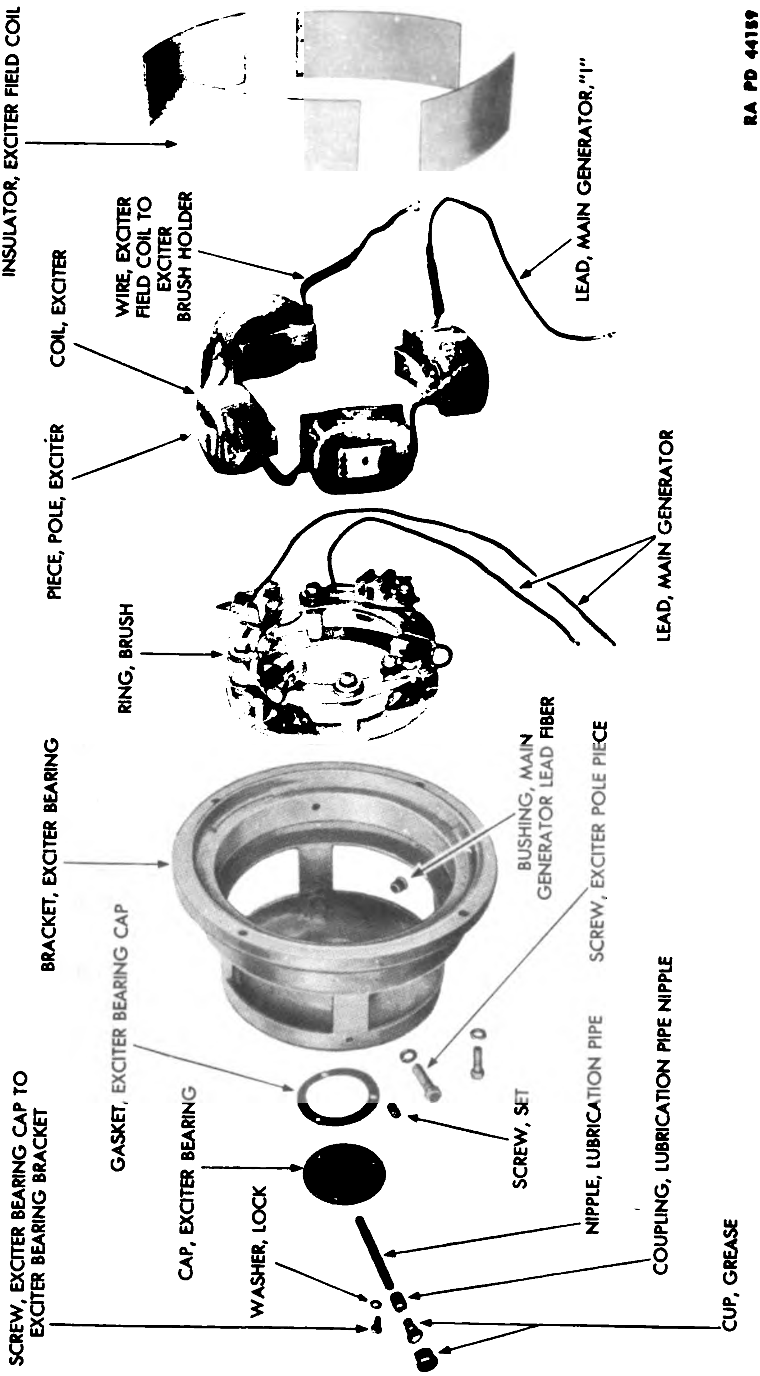


Figure 54 — Exciter Bearing Bracket Assembly — Exploded View

MAIN GENERATOR AND EXCITER

(5) Assemble Exciter Bearing Bracket (fig. 54).

BATTERY, dry cell (1½-volt)	PLIERS
COMPASS, magnetic	SCREWDRIVER
FILE	TAPE
GLYPTAL, No. 1209, black	WELDING EQUIPMENT
HAMMER	WRENCH, socket, $\frac{9}{16}$-in.
LOOM	WRENCH, socket-head setscrew, ⅜-in.

(a) Place exciter bearing bracket on bench, open end up. Examine inside of bracket for burs where brush ring seats. Remove burs if present (file).

(b) Tap main generator lead fiber bushing into place in bracket (hammer).

(c) Start setscrews in brush ring.

(d) Place brush ring in position in bracket so exciter brush referred to in step (4) *(n)* is next to main generator lead fiber bushing installed in step *(b)*. Pull two main generator leads through bushing. Tighten socket-head setscrews which clamp brush ring in bracket (⅜-in. socket-head setscrew wrench) (fig. 32).

(e) Turn exciter bearing bracket so main generator lead bushing is to the front.

(f) Place exciter pole insulators in position on an exciter field coil, and secure to coil with tape. Slide an exciter pole piece through the coil, so insulators are between coil and pole piece. Turn coil and pole piece so leads point down, and hold assembly in position in bracket to right of main generator lead bushing. Start exciter pole piece screw and lock washer into pole piece through screw hole in bracket.

(g) Assemble another exciter field coil, two insulators and pole piece (as in step *(f)* above), and secure in place in bracket to right of coil already installed with pole piece screw. The leads on this coil must point up.

(h) Continue on around the bracket and install remaining exciter field coils. Alternate the directions of the coil leads. Leads from the last installed coil must point up.

(i) Place exciter field coil insulators in position between the exciter field coils and bracket. Care must be exercised to keep insulators from between pole pieces and bracket. Tighten exciter pole piece cap screws ($\frac{9}{16}$-in. socket wrench).

(j) Clean insulation from ends of coil leads for a distance of about 1 inch. Slide loom (1½ in. long) down over every other lead. Connect coils in series by twisting bare ends of adjacent coil leads together (pliers). Do not connect left-hand lead of first coil installed and right-hand lead of last coil installed. Connect 16-inch main

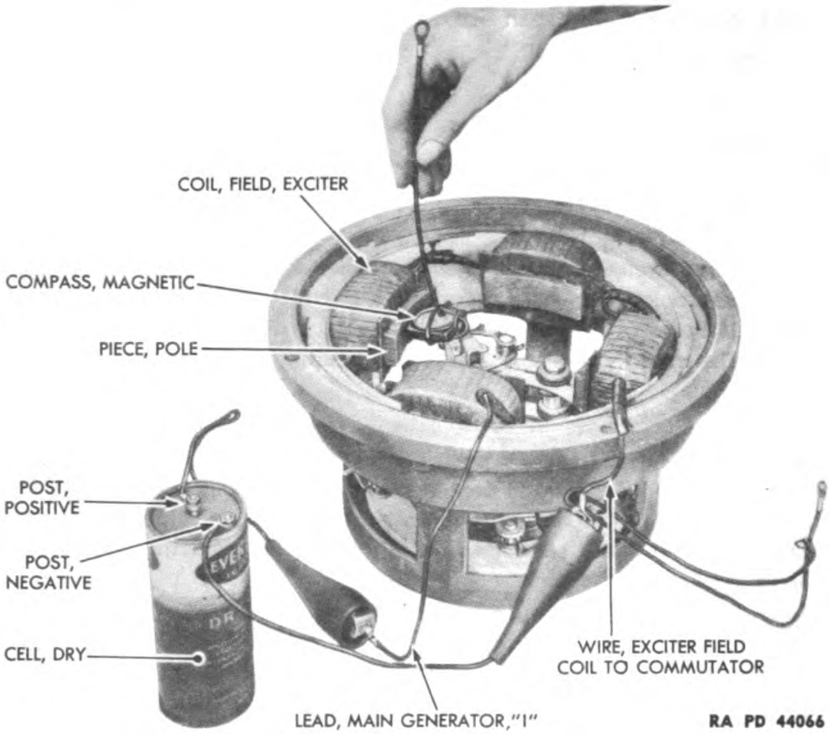


Figure 55 — Exciter Field Coil Polarity Test

generator lead marked "I" to right-hand lead of last coil installed. Connect 5-inch exciter field coil to exciter brush holder wire, to left-hand lead of first coil installed. Weld wires together on all five connections (welding equipment). Pull loom up over each connection and wrap with tape. Paint tape (No. 1209 black glyptal).

(k) Push all connected coil leads down between exciter field coils.

(l) Test and correct polarity of coils as follows:

1. Connect positive post of a 1½-volt dry cell battery to main generator lead "1." Connect negative post to exciter field coil to exciter wire (fig. 55).

2. Hold a magnetic compass edgewise against pole piece of the first coil installed so that the needle points "south."

3. Move compass to the same position on coil to the right. The needle should now point "north."

4. Move compass to the next coil to the right. Needle should point "south."

5. Move compass to remaining coil to the right. Needle should point "north."

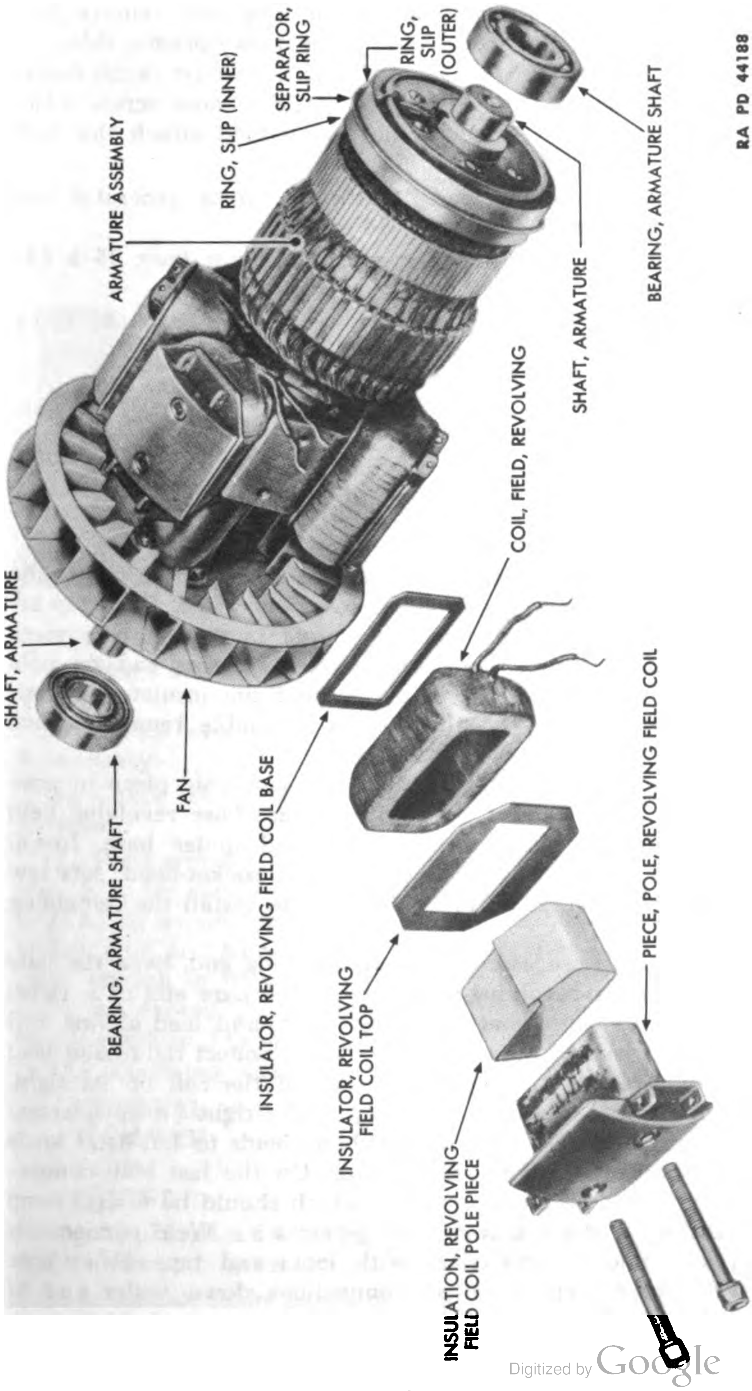


Figure 56 — Complete Armature Assembly

6. If compass points the wrong way on any coil, remove pole piece. Turn coil over and insert pole piece from opposite side.

(m) Attach 5-inch exciter field coil wire to exciter brush holder immediately below it (screwdriver). NOTE: Same screw which secures brush pigtail to brush holder is used to attach this wire (fig. 54).

(n) Pull main generator lead "1" through main generator lead bushing with other two leads (fig. 54).

(o) Check exciter field coils for an open circuit (par. 25 **b** (4) *(a)*). Repair if open.

(p) Check exciter field coils for a ground (par. 25 **b** (4) *(b)*). Repair if grounded.

(6) Assemble Complete Armature Assembly (fig. 56).

GLYPTAL, No. 1209, black	PRESS, arbor
HAMMER	TAPE
LOOM	WELDING EQUIPMENT
PILOT, hollow	WRENCH, socket-head setscrew, $\frac{5}{16}$-in.
PLIERS	

(a) Place a revolving field coil pole piece on bench, large side down. Wrap pole piece insulation around pole piece. Push top revolving field coil insulator down over pole piece and pole piece insulation. Place revolving field coil over insulators and on pole piece, flat side down. Lay base revolving field coil insulator in position on top of coil. Repeat the step to assemble remaining five revolving field coils and pole pieces.

(b) Place assembled revolving field coil and pole piece in position on spider base of armature shaft. Be sure base revolving field coil insulator is not between pole piece and spider base. Install pole piece to spider base screws ($\frac{5}{16}$-in. socket-head setscrew wrench). Tighten securely. Repeat the step to install the remaining revolving field coils.

(c) Facing armature assembly from slip ring end, twist the bare end of a slip-ring-to-revolving-field wire to the bare end of a right-hand lead from a coil (pliers). Connect left-hand lead of first coil to the left-hand lead of the coil on its right. Connect right-hand lead of this second coil to the right-hand lead of the coil on its right. Continue on around armature assembly to the right (turning armature assembly to left) connecting left-hand leads to left-hand leads and right-hand leads to right-hand leads. On the last coil, connect the only lead remaining disconnected, which should be a right-hand lead, to the other slip-ring-to-revolving-field wire. Weld connections (welding equipment), and cover with loom and tape. Paint tape (No. 1209 black glyptal). Push connections down under end of exciter armature. Wrap connections with linen tape to hold them in place. Paint tape (No. 1209 black glyptal).

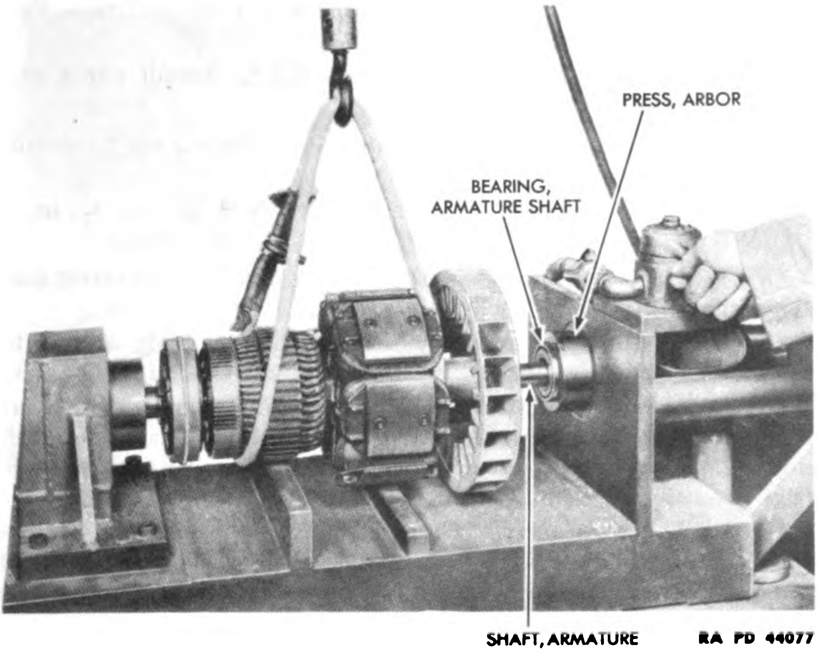


Figure 57 — Pressing Armature Shaft Bearing on Shaft

(d) Check revolving field for open circuit (par. 25 **b** (2)). Repair if necessary.

(e) Check revolving field for ground (par. 25 **b** (2)). Repair if necessary.

(f) Press armature shaft bearings on armature shaft (arbor press) (fig. 57). Be sure open face of bearings is toward ends of shaft. NOTE: In an emergency, bearings can be driven onto shaft with a hollow pilot and hammer. The inside diameter of the pilot must be large enough to fit over end of rotor shaft, and outside diameter must not exceed the diameter of the inner race of the bearing. A short length of 1½-inch iron pipe can be used as a pilot.

(7) ASSEMBLE STATOR.

GLYPTAL, red
HAMMER
LOOM
PLIERS
SCREWDRIVER
TAPE
WELDING EQUIPMENT

(a) Tap insulator bushing into place in body (hammer). Insert ends of six main generator leads through bushing.

(b) Connect main generator leads "A," "B," "C," "1A,", "1B," and "1C" to wires as tagged at disassembly (pliers). Weld connections

(welding equipment). Cover connections with loom and tape. Paint tape (No. 1209 black glyptal).

(c) Place name plate in position on body. Install name plate screws (screwdriver).

(8) INSTALL COMPLETE ARMATURE ASSEMBLY AND ARMATURE SHAFT BRACKET.

WRENCH, open-end, ½-in.	WRENCH, socket, 9/16-in.
WRENCH, socket, ½-in.	WRENCH, Stillson

(a) Set body and stator assembly on bench, with end nearest main generator leads toward back of bench (fig. 51).

(b) Insert armature assembly into position in body and stator assembly, slip ring end first, from front of bench (fig. 51).

(c) Slip armature shaft bearing bracket on fan end of armature. Revolve bracket so that lubrication pipe nipple hole is on top right side. Install four cap screws and lock washers (9/16-in. socket wrench) (figs. 29 and 51).

(d) Insert felt washer into grease retainer. Place grease retainer and gasket in position over armature shaft on bearing bracket. Install three cap screws and lock washers (½-in. socket wrench) (fig. 51).

(e) Screw elbow onto lubrication pipe nipple. Screw the nipple into armature shaft bearing bracket (Stillson wrench). Tighten grease cup in elbow (½-in. open-end wrench) (fig. 51).

(9) INSTALL EXCITER BEARING BRACKET ASSEMBLY.

SCREWDRIVER	WRENCH, socket, ½-in.
WRENCH, open-end, ½-in.	WRENCH, socket, 9/16-in.

(a) Turn generator assembly on bench so slip ring end is to front of bench. Slide stator body as near edge of bench as possible. CAUTION: Be sure bench is bolted to floor.

(b) Inspect bare end of slip-ring-to-revolving-field wire, where it is attached to outer slip ring. Bend bare end (screwdriver) if necessary so that it makes no contact with mica. This is a precaution against possible grounding.

(c) Inspect brushes in exciter bearing bracket to be sure all are lifted up in their plates. Slide bracket on end of armature, with bracket turned so that the main generator leads protrude from top right side of bracket.

(d) Install four cap screws and lock washers (9/16-in. socket wrench).

(e) Using a new gasket, place exciter bearing cap in position on end of exciter bearing bracket (fig. 54). Be sure lubrication pipe nipple hole points to left (fig. 54). Install three screws and lock washers (½-in. socket wrench) (fig. 54).

MAIN GENERATOR AND EXCITER

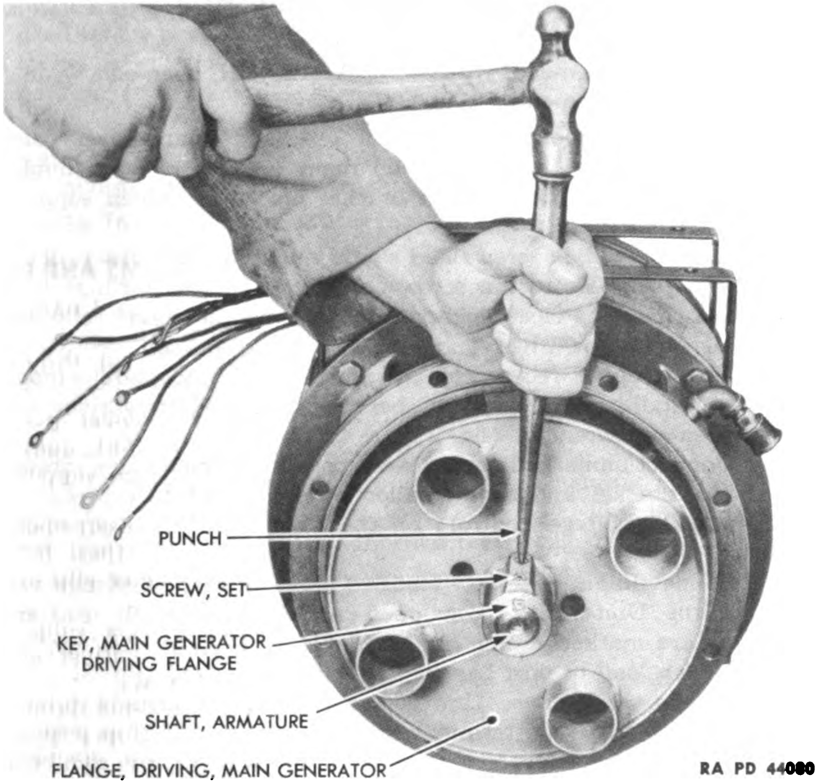


Figure 58 — Installing Main Generator Driving Flange

(f) Install lubrication pipe nipple, coupling and grease cup into exciter bearing cap (½-in. open-end wrench) (fig. 54).

(g) Lift tension arm on each of the brushes and let brushes drop against exciter commutator or slip ring.

(10) INSTALL MAIN GENERATOR DRIVING FLANGE.

HAMMER	PUNCH, center
HAMMER, soft	WRENCH, socket-head setscrew, $^{9}/_{64}$-in.

(a) Tap main generator driving flange key into position in keyway in armature shaft (hammer) (fig. 58).

(b) Drive main generator driving flange on armature shaft (soft hammer) (fig. 58).

(c) Tighten setscrews in hub of driving flange ($^{9}/_{64}$-in. socket-head setscrew wrench). Center punch hub next to screws, to lock screws in position (punch and hammer) (fig. 58).

(11) INSTALL INSTRUMENT PANEL, TOOL BOX, AND CHANGE-OVER PANEL.

WRENCH, open-end, 5/16-in.
WRENCH, open-end, 7/16-in.
WRENCH, open-end, 1/2-in.

(a) Place switchboard panel, tool box, and change-over panel assembly in position on bracket on main generator. Work duplex receptacle into position through bracket on stator, which supports tool box (fig. 25).

(b) Install tool box screws and safety nuts (fig. 25). Insert choke control clip beneath nut on screw on right-hand side farthest from switchboard panel. Place choke control wire conduit under clip and tighten screw (screwdriver and 1/2-in. open-end wrench).

(c) Hold duplex receptacle in position on tool box support bracket. Install screws, lock washers, and nuts (screwdriver and 7/16-in. open-end wrench) (fig. 25).

(d) Connect unmarked main generator leads (which come through the exciter bracket and have smaller holes in tips) to top post on field rheostat (voltage control) on the Unit M5 (5/16-in. open-end wrench).

(e) Connect main generator leads to posts on rear of change-over panel of the Unit M5 (7/16-in. open-end wrench). Each lead and each post are marked either "1," "1A," "1B," "1C," "A," "B," or "C". Connect each lead to post bearing same mark as lead (fig. 71).

(f) On the single-phase Unit M6, connect main generator leads "2," "4," "5," and "5A" to terminals "2," "4," "5," and "5A" of change-over panel. Connect main generator lead "M" which runs from commutator to rear post of time delay relay marked "M." Connect main generator lead "M" which runs from slip ring to front post of time delay relay marked "M" (7/16-in. open-end wrench).

(g) On the single- and 3-phase Unit M6, connect main generator leads "A," "B," and "C" to bottom clips of fuses "A," "B," and "C." Connect main generator lead "M" which runs from commutator to rear post of time delay relay marked "M." Connect main generator lead "M" which runs from slip ring to front post of time delay relay marked "M" (7/16-in. open-end wrench).

28. INSTALLATION.

a. Equipment.

CHAIN (or rope)
HOIST, chain
SCREWDRIVER
WRENCH, open-end, 3/8-in.
WRENCH, open-end, 1/2-in.
WRENCH, open-end, 9/16-in.
WRENCH, open-end, 3/4-in.

b. Procedure.

(1) Using a chain or rope sling, lower main generator and instrument panel assembly into position in frame (chain hoist) (fig. 24).

MAIN GENERATOR AND EXCITER

(2) Turn engine flywheel so that one of coupling studs is in top dead center position. Turn generator driving flange so that a coupling socket is at top dead center. Slide main generator forward into position (two men).

(3) Install main generator to bell housing cap screws and lock washers (9/16-in. open-end wrench). Be sure to install the one short screw directly behind the starting motor (fig. 134).

(4) Install main generator mounting cap screws and lock washers (3/4-in. open-end wrench) (fig. 134).

(5) Place main generator fan cover in position on generator, and secure in place by tightening clamp screws (screwdriver) (fig. 133).

(6) Connect oil pressure gage line to "T" on cylinder block (1/2-in. open-end wrench) (fig. 137).

(7) Connect cable to starting motor (9/16-in. open-end wrench) (fig. 133).

(8) Connect ammeter wire to battery charging generator regulator post marked "B" (screwdriver). NOTE: This is the shorter of the two wires from the switchboard panel (fig. 133).

(9) Connect switch wire to ignition coil terminal marked "—" (3/8-in. open-end wrench).

(10) Connect choke control (par. 154).

(11) Place battery to starter switch cable in position under clip on right rear engine mounting cap screw. Tighten cap screw (3/4-in. open-end wrench). Connect cable to positive post of battery (9/16-in. open-end wrench).

(12) Place outlet receptacle in position on frame, with socket marked "A" up. Install mounting screws and safety nuts (screwdriver and 1/2-in. open-end wrench) (pars. 62 and 63).

(13) Test and adjust main generator (par. 29).

(14) Check all brushes to be sure they are down against commutator or slip ring. Slide brush cover over exciter bearing bracket, with screws on right side of generator, and with mesh across bottom of bracket. Install brush cover screws and nuts (screwdriver and 1/2-in. open-end wrench). CAUTION: Do not draw screws too tight because of danger of creating a ground. Tighten only until ends of guard are about 1/2 inch apart.

(15) Install housing (par. 19).

29. ADJUSTMENTS.

a. Equipment.

WRENCH, open-end, 5/16-in.
WRENCH, open-end, 3/8-in.
WRENCH, open-end, 7/16-in.
WRENCH socket-head set-screw, 3/8-in.

b. Procedure.

(1) ADJUST UNIT M5 TO DELIVER 60 CYCLES.

WRENCH, open-end, ⅜-in. WRENCH, open-end, 7/16-in.
WRENCH, open-end, ½-in.

(a) Connect change-over bars on change-over panel between binding posts "2" and "3," "RA" and "A," "RB" and "B," "RC" and "C" (½-in. open-end wrench) (fig. 72).

(b) Start engine and adjust governor adjusting screw (figs. 186 and 206) until frequency meter shows 61 or 62 cycles with no load on generator (7/16- and ⅜-in. open-end wrenches) (par. 148).

(c) Put load on generator and observe frequency meter. It should register 60 cycles. Adjust governor adjusting screw if necessary to get proper reading (7/16- and ⅜-in. open-end wrenches) (figs. 186 and 206).

(2) ADJUST UNIT M5 TO DELIVER 50 CYCLES.

WRENCH, open-end, ⅜-in. WRENCH, open-end, 7/16-in.

(a) Connect change-over bars on change-over panel between binding posts "1" and "2," "1A" and "RA," "1B" and "RB," "1C" and "RC" (7/16-in. open-end wrench) (fig. 72).

(b) Start engine and adjust governor adjusting screw (figs. 186 and 206) until frequency meter shows 51 or 52 cycles with no load on main generator (7/16- and ⅜-in. open-end wrenches) (par. 148).

(c) Put load on generator and observe frequency meter. It should register 50 cycles. Adjust governor adjusting screw if necessary to get proper reading (7/16- and ⅜-in. open-end wrenches) (par. 148).

(3) ADJUST SINGLE- AND 3-PHASE UNIT M6 TO DELIVER 3-PHASE CURRENT.

WRENCH, open-end, 7/16-in.

(a) Some Units M6 can be adjusted to deliver 3-phase current. Those bearing serial numbers 377 to 726, inclusive, have a change-over panel similar to the change-over panel on the M5, and can be adjusted to function as 3-phase units. Connect change-over bars on change-over between binding posts "A" and "A," "B" and "B," "C" and "C," "1" and "2."

(4) ADJUST SINGLE- AND 3-PHASE UNIT M6 TO DELIVER SINGLE-PHASE CURRENT.

WRENCH, open-end, 7/16-in.

(a) Units M6 bearing serial numbers 1 to 266, inclusive, and numbers 367 to 376, inclusive, are exclusively single-phase generators but can be converted to deliver 3-phase current by making certain changes in wiring (step (5) below).

(b) Units M6 bearing serial numbers 377 to 726, inclusive, can be adjusted to deliver single-phase current from the 19-pole outlet

receptacle. Connect change-over bars on change-over panel between binding posts "A" and "4," "B" and the unmarked post immediately below it, "C" and "5A," "2" and "3" (7/16-in. open-end wrench).

(5) CONVERT SINGLE-PHASE UNIT M6 TO DELIVER 3-PHASE OUTPUT.

WRENCH, open-end, 5/16-in. WRENCH, open-end, 3/8-in.

(a) Remove the 19-pole outlet receptacle (par. 63) and install 3-pole outlet receptacle in its place (par. 62).

(b) Connect wire from "C" socket of outlet receptacle to terminal "5A" on circuit breaker (5/16-in. open-end wrench) (fig. 9).

(c) Connect wire from "B" socket of outlet receptacle to top clip of fuse "5" (3/8-in. open-end wrench) (fig. 9).

(d) Remove both wires from lower left-hand terminal "4" (next to frequency meter) of circuit breaker (5/16-in. open-end wrench) (fig. 9).

(e) Connect wire from "A" socket of outlet receptacle to lower left-hand terminal "4" (next to frequency meter) of circuit breaker (5/16-in. open-end wrench) (fig. 9).

(6) LOWER VOLTAGE OUTPUT.

WRENCH, socket-head setscrew, 3/8-in.

(a) Under no-load conditions, the voltmeter will often show several volts more than are delivered under load. As this is a normal condition, no adjustment is necessary. However, if for any reason the voltage must be lowered, the procedure is as follows:

1. Loosen socket-head setscrews which lock the generator brush ring to the exciter bearing bracket (3/8-in. socket-head setscrew wrench) (fig. 32).

2. Turn brush ring (counterclockwise from rear of unit) until desired voltage is obtained.

3. Tighten setscrews (3/8-in. socket-head setscrew wrench) (fig. 32).

Section VI

INSTRUMENTS AND GAGES

30. DESCRIPTION AND CONSTRUCTION.

a. Oil Pressure Gage. The oil pressure gage is an indicating instrument only. It indicates whether or not the oil pump is working. As the pump builds up pressure, oil is forced through the oil pressure gage line to the gage. As the oil is forced into the mechanism (which consists of a crescent-shaped tube), the tube straightens out. This moves the hand from zero toward 50 on the dial.

b. Battery Charging Generator Ammeter.

(1) Of standard automotive design, the battery charging generator ammeter registers up to 30 amperes of current flow in either direction through it. Current passing through a coil sets up a magnetic field which attracts or repels a piece of iron. The iron is linked to a hand which indicates the direction of the current (i.e., charge or discharge) and the amount of current (i.e., number of amperes).

(2) The function of the ammeter is to register rate of charge or discharge in engine battery circuit.

c. Alternating-current Voltmeter. A standard alternating-current voltmeter is provided to register voltage of main generator output. Range of voltmeter is from zero to 150 volts.

d. Alternating-current Ammeter. An alternating-current ammeter is provided to register amount of current in main generator output. Range of the ammeter is from zero to 30 amperes.

e. Frequency Meter.

(1) A frequency meter is provided to measure the number of cycles per second.

(2) On the Unit M5, the frequency meter is a 10-reed instrument. A 5-reed unit is used on the M6.

INSTRUMENTS AND GAGES

31. SPECIFICATIONS.

a. Oil Pressure Gage.

Make	Stewart-Warner
Model	444029
Range	0 to 50 lb

b. Direct-current Ammeter.

Make	Stewart-Warner
Model	440021
Range	—30 to +30 amp

c. Alternating-current Voltmeter.

Make	Triplett
Model	332 J.P.
Range	0 to 150 volts

d. Alternating-current Ammeter.

Make	Triplett
Model	332 J.P.
Range	0 to 30 amp

e. Frequency Meter.

Make	Triplett
Model	372
Range (M5)	48 to 52 and 58 to 62 cycles
Reeds (M5)	10
Reeds (M6)	5

32. TROUBLE SHOOTING.

a. Fails to Register.

Possible Cause	Possible Remedy
Defective connection to instrument.	Repair connection.
Defective mechanism.	Replace mechanism or instrument.

b. Registers Incorrectly.

Out of adjustment.	Adjust or replace instrument.
Defective connection to instrument.	Repair connection.
Defective mechanism.	Replace mechanism or instrument.

33. OIL PRESSURE GAGE.

a. Removal of Oil Pressure Gage (fig. 59).

WRENCH, open-end, 3/8-in. WRENCH, open-end, 1/2-in.

(1) Disconnect oil pressure gage line from oil gage (1/2-in. open-end wrench).

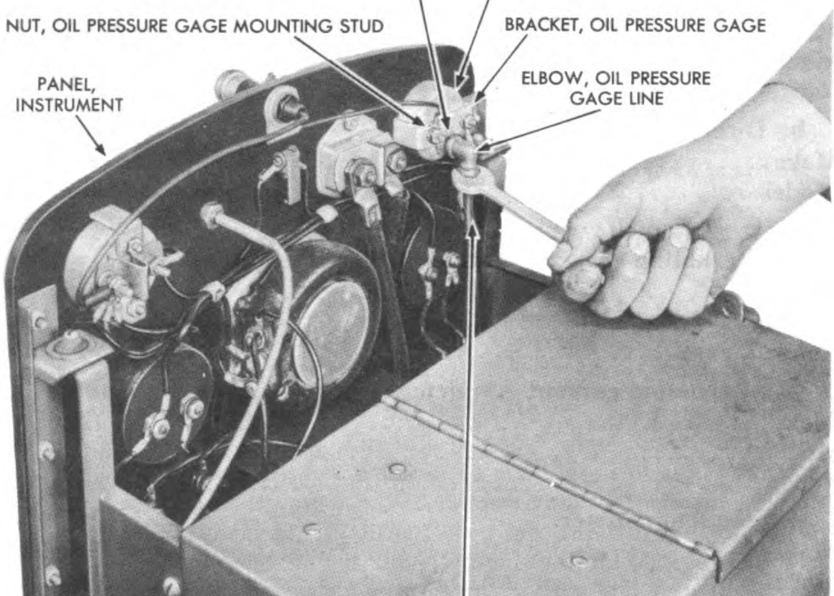


Figure 59 — Removing Oil Pressure Gage

(2) Remove oil pressure gage mounting stud nuts and lock washers (3/8-in. open-end wrench).

(3) Lift oil pressure gage bracket from engine side of instrument panel, and remove oil pressure gage from face of switchboard.

b. Inspection and Test of Oil Pressure Gage.

COMPRESSED AIR

(1) Check functioning of oil pressure gage by attaching compressed air hose to nipple. Introduce low air pressure (10 to 20 lb) to gage. If hand moves from zero toward 50 on dial, and no air leak can be detected, gage is in satisfactory condition.

(2) Inspect bezel and glass assembly; if broken, replace.

(3) Examine elbow, washers, and nuts to see if any are broken or have damaged threads.

c. Installation of Oil Pressure Gage (fig. 59).

WRENCH, open-end, 3/8-in. WRENCH, open-end, 1/2-in.

(1) Place oil pressure gage in position from the front of switchboard. Place oil pressure gage bracket in position on back of oil gage

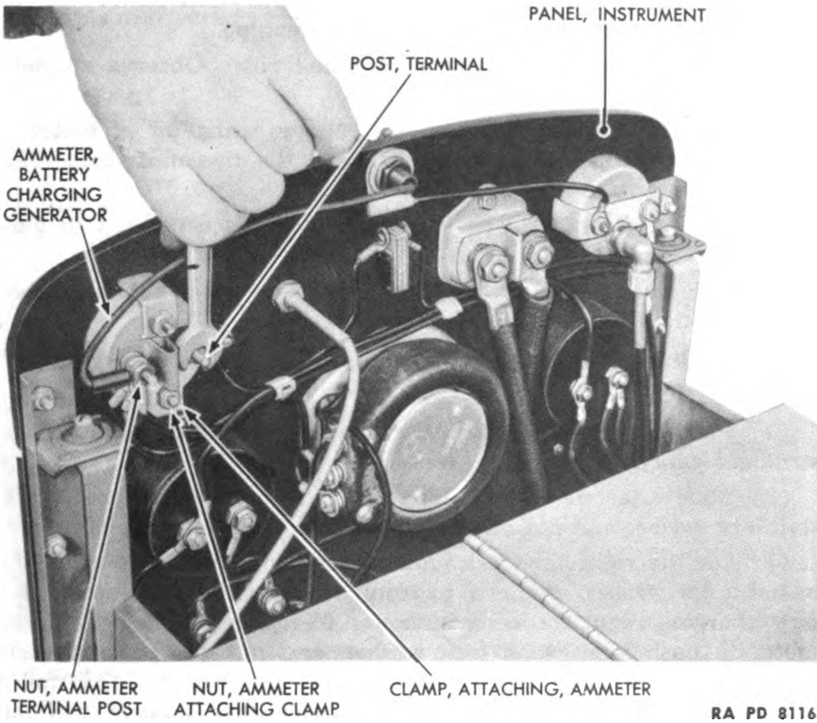


Figure 60 — Removing Battery Charging Generator Ammeter

on engine side of switchboard. Install oil pressure gage mounting flat washers, lock washers, and nuts (3/8-in. open-end wrench).

(2) Connect oil pressure gage line to elbow (1/2-in. open-end wrench).

34. BATTERY CHARGING GENERATOR AMMETER.

a. Removal of Battery Charging Generator Ammeter (fig. 60).

AMMETER	WRENCH, open-end, 11/32-in.
BATTERY, 6-volt, dry-cell	WRENCH, open-end, 3/8-in.

(1) Remove two ammeter terminal post nuts, lock washers; four washers, and five wires (11/32-in. open-end wrench).

(2) Remove ammeter attaching clamp nuts, lock washers, and clamps (3/8-in. open-end wrench).

(3) Lift ammeter from instrument panel.

b. Inspection and Test of Battery Charging Generator Ammeter.

(1) Compare functioning of ammeter with an ammeter of known good quality as follows:

(a) Connect leads from posts of a 6-volt dry-cell battery to terminal posts of ammeter. Observe ammeter reading.

(b) Reverse leads on ammeter terminal posts. Observe ammeter reading.

(c) Repeat substeps *(a)* and *(b)* above, using an ammeter of known good quality. If readings between the two ammeters differ appreciably, replace ammeter.

(2) Inspect glass to see if it is broken. Replace bezel with glass assembly if broken.

(3) Examine nuts and washers to see if they are broken. Inspect threads of nuts. Replace damaged parts.

c. Installation of Battery Charging Generator Ammeter.

WRENCH, open-end, 11/32-in. WRENCH, open-end, 3/8-in.

(1) Place battery charging generator ammeter in position on instrument panel.

(2) Slide attaching clamps into position over attaching studs. Install lock washer and nut on each stud (3/8-in. open-end wrench).

(3) On the right-hand terminal of the ammeter (marked "+"), install a flat washer, ammeter to trouble lamp wire, ammeter to battery charging regulator wire, ammeter to ignition switch wire, ammeter to dash lamp wire, lock washer, and nut (11/32-in. open-end wrench) (fig. 60). On right-hand terminal (marked "—"), install a flat washer, starter switch to ammeter wire, lock washer, and nut (11/32-in. open-end wrench) (fig. 60).

35. ALTERNATING-CURRENT VOLTMETER.

a. Removal of Alternating-current Voltmeter (fig. 61).

SCREWDRIVER WRENCH, open-end, 3/8-in.
WRENCH, open-end, 1/4-in.

(1) Remove nut and lock washer from each terminal (3/8-in. open-end wrench). Remove four wires from terminals.

(2) Remove attaching screws, nuts, and lock washers (screwdriver and 1/4-in. open-end wrench).

(3) Lift voltmeter from face of instrument panel.

b. Inspection and Test of Alternating-current Voltmeter.

VOLTMETER, alternating-current

(1) Test functioning of voltmeter as follows:

(a) From an unvarying source of approximately 110-volt, 50- or 60-cycle alternating current, attach lead to each voltmeter terminal. Observe voltmeter reading.

(b) Connect another voltmeter known to be accurate across the voltmeter terminals. Observe voltmeter reading.

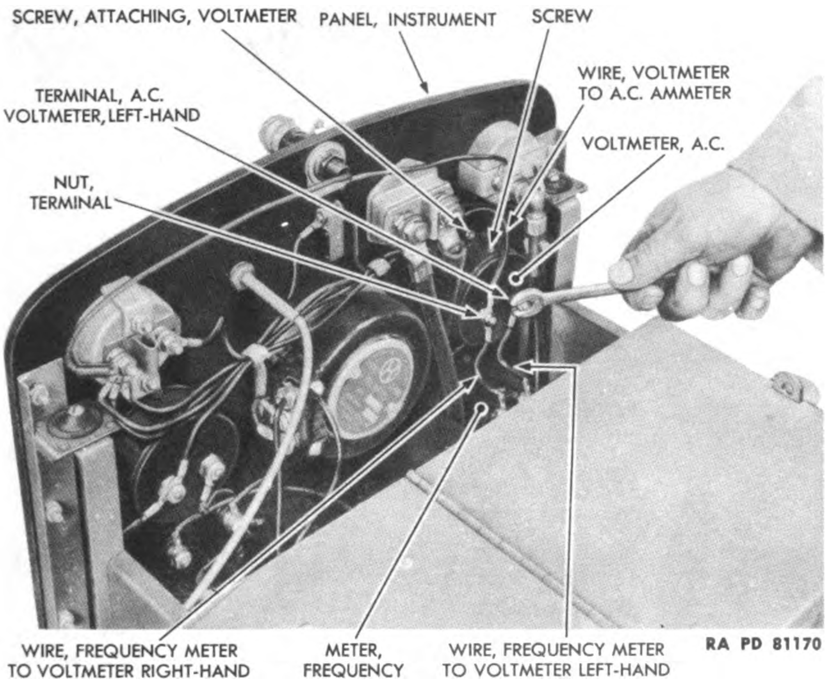


Figure 61 — Removing Alternating-current Voltmeter

(c) If voltmeter being tested registers differently than the one known to be accurate, replace the voltmeter.

(2) Inspect rear cap; replace if broken.

(3) Examine screws, nuts, and lock washers to see if they are broken or have damaged threads. Replace defective parts.

c. **Installation of Alternating-current Voltmeter** (fig. 61).

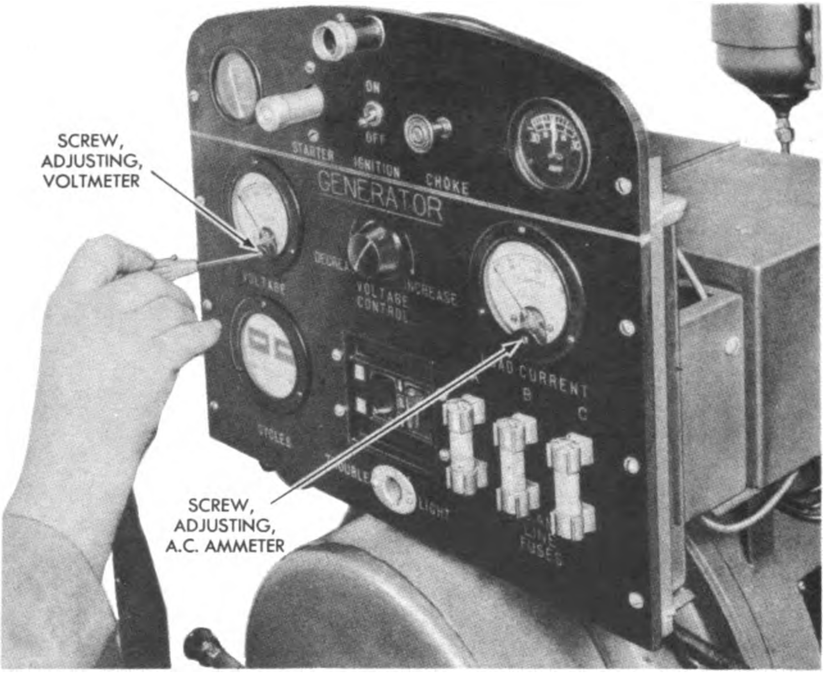
SCREWDRIVER — WRENCH, open-end, 3/8-in.
WRENCH, open-end, 1/4-in.

(1) Place alternating-current voltmeter in position on instrument panel.

(2) Install screws, lock washers, and nuts (screwdriver and 1/4-in. open-end wrench).

(3) On voltmeter right-hand terminal, next to voltage control, install frequency meter to voltmeter right-hand wire, voltmeter to alternating-current ammeter wire, lock washer, and nut (3/8-in. open-end wrench).

(4) On left-hand voltmeter terminal, next to edge of instrument panel, install frequency meter to voltmeter left-hand wire, voltmeter



RA PD 44123

Figure 62 — Adjusting Alternating-current Voltmeter

to fuse "A" ("4" on single-phase Unit M6) wire, lock washer, and nut (3/8-in. open-end wrench).

d. Adjustment of Alternating-current Voltmeter (fig. 62).

SCREWDRIVER

With engine of unit not running, turn voltmeter adjusting screw to right or left until hand points to zero (screwdriver).

36. ALTERNATING-CURRENT AMMETER.

a. Removal of Alternating-current Ammeter (fig. 63).

SCREWDRIVER — WRENCH, open-end, 3/8-in.
WRENCH, open-end, 1/4-in.

(1) Remove nuts, lock washers, and three wires from ammeter terminals (3/8-in. open-end wrench).

(2) Remove screws, lock washers, and nuts (screwdriver and 1/4-in. open-end wrench).

(3) Lift alternating-current ammeter from face of instrument panel.

b. Inspection and Test of Alternating-current Ammeter.

AMMETER

(1) Test alternating-current ammeter as follows:

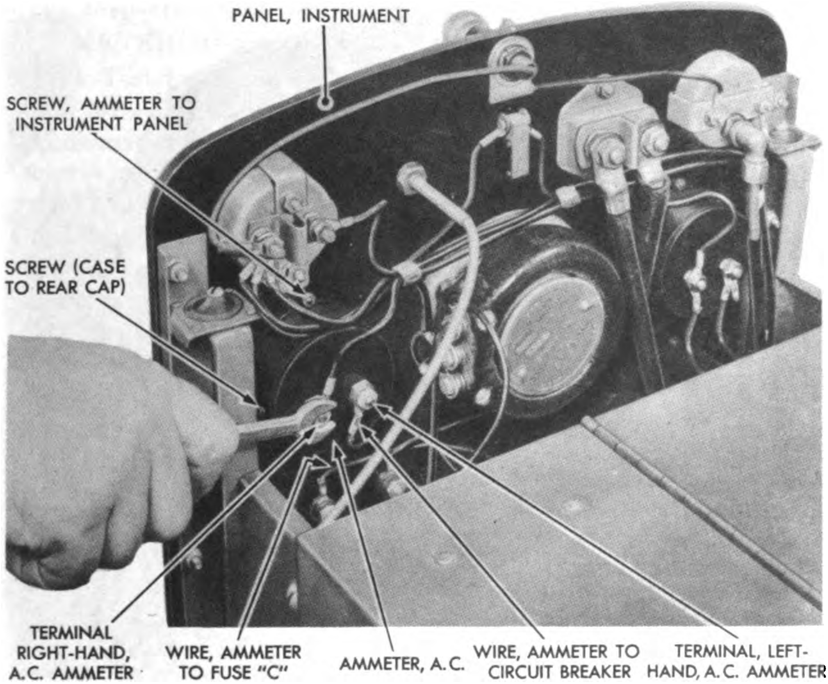


Figure 63 — Removing Alternating-current Ammeter

(a) Connect leads from a source of approximately 30 amperes, 50- to 60-cycle alternating-current to terminals of ammeter. CAUTION: Do not connect the ammeter directly across a power line. Observe reading. Disconnect leads from ammeter.

(b) Connect same leads to terminals of an ammeter known to be accurate. Observe reading.

(c) If the two readings vary, replace ammeter.

(2) Inspect rear cap; replace if broken.

(3) Examine all screws, nuts, and washers to see if any are broken or if threads are damaged. Replace defective parts.

c. **Installation of Alternating-current Ammeter** (fig. 63).

SCREWDRIVER — WRENCH, open-end, 3/8-in.
WRENCH, open-end, 1/4-in.

(1) Place ammeter in position on instrument panel and install ammeter-to-instrument panel, screws, lock washers, and nuts (screwdriver and 1/4-in. open-end wrench).

(2) On left-hand alternating-current ammeter terminal, next to field rheostat, install ammeter to circuit breaker wire, lock washer, and nut (3/8-in. open-end wrench).

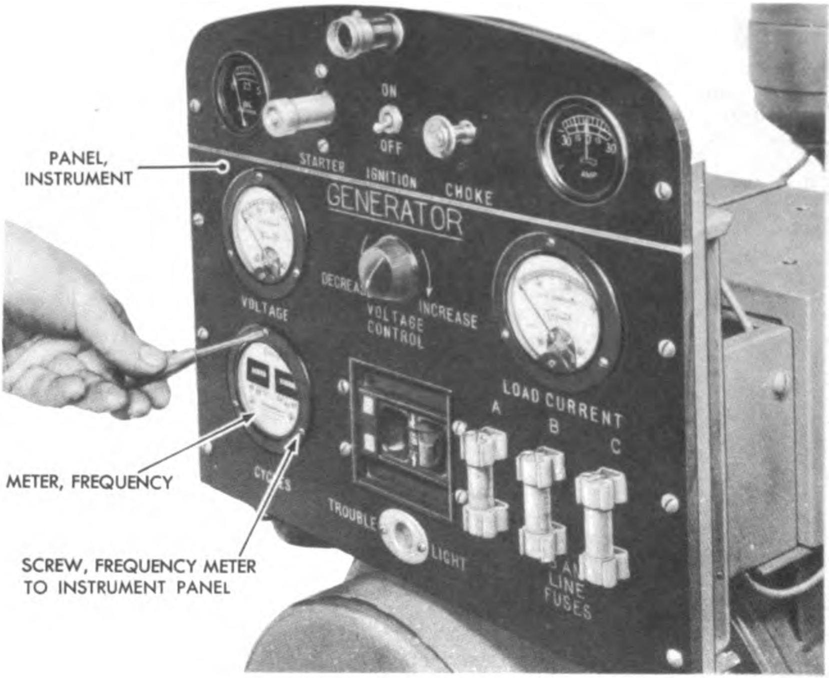


Figure 64 — Removing Frequency Meter

(3) On right-hand ammeter terminal, toward edge of panel, install ammeter to fuse "C" ("5A" on single-phase Unit M6) wire, ammeter to voltmeter wire, lock washer, and nut (3/8-in. open-end wrench).

d. Adjustment of Alternating-current Ammeter (fig. 62).

SCREWDRIVER

With engine not running, turn alternating-current ammeter adjusting screw to right or left until ammeter hand points to zero (screwdriver).

37. FREQUENCY METER.

a. Removal of Frequency Meter.

SCREWDRIVER — WRENCH, open-end, 3/8-in.
WRENCH, open-end, 1/4-in.

(1) Disconnect wires from frequency meter terminals on rear of instrument panel (3/8-in. open-end wrench) (fig. 61).

(2) Remove nuts, screws, and lock washers from meter on front of instrument panel (screwdriver and 1/4-in. open-end wrench) (fig. 64).

(3) Lift frequency meter from face of instrument panel.

b. Inspection and Test of Frequency Meter.

METER, frequency

(1) Test frequency meter as follows:

(a) From an unvarying source of 50-cycle alternating-current, and approximately 110 volts, connect leads to frequency meter terminals. Observe reading. Disconnect leads.

(b) Connect same leads to a frequency meter of known accuracy. Observe reading.

(c) If readings differ, replace frequency meter.

(2) Inspect rear cap; replace if cracked..

(3) Examine all screws, nuts, and washers to see if they are broken or have damaged threads. Replace defective parts.

c. Installation of Frequency Meter.

SCREWDRIVER
WRENCH, open-end, 3/8-in.
WRENCH, open-end, 1/4-in.

(1) Place frequency meter in position on instrument panel (fig. 61).

(2) Install frequency meter to panel screws, lock washers, and nuts (screwdriver and 1/4-in. open-end wrench) (fig. 64).

(3) On left-hand terminal, next to edge of instrument panel, install left-hand voltmeter-to-frequency-meter wire (also frequency meter to fuse "A" if single- and 3-phase Unit M6; frequency meter to fuse "4" on single-phase Unit M6), lock washer, and nut (3/8-in. open-end wrench) (fig. 61).

(4) On right-hand terminal, next to field rheostat, install right-hand voltmeter-to-frequency-meter wire, lock washer, and nut (3/8-in. open-end wrench) (fig. 61).

Section VII

INSTRUMENT PANEL

38. DESCRIPTION AND CONSTRUCTION.

a. Instrument Panel.

(1) Located at the rear of the unit, the instrument panel furnishes a consolidated location for the switches, fuses, and instruments of the unit (fig. 65). Grouped at the top are the engine instruments and controls. Included in this group are the oil pressure gage, starter switch, ignition switch, choke control, and battery charging generator ammeter. Grouped beneath the engine controls are the main generator instruments and controls. This group consists of an alternating-current voltmeter, field rheostat (voltage control), alternating-current ammeter, frequency meter, circuit breaker, and three fuses. At the extreme top center of the panel is a dash lamp. At the extreme bottom center is a trouble light socket.

(2) Constructed of Bakelite, the instrument panel is cut and drilled to receive all instruments and screws. Directive lettering to explain and identify the instruments is cut on the face of the panel. The lettering indentations are painted white to make the lettering more legible.

INSTRUMENT PANEL

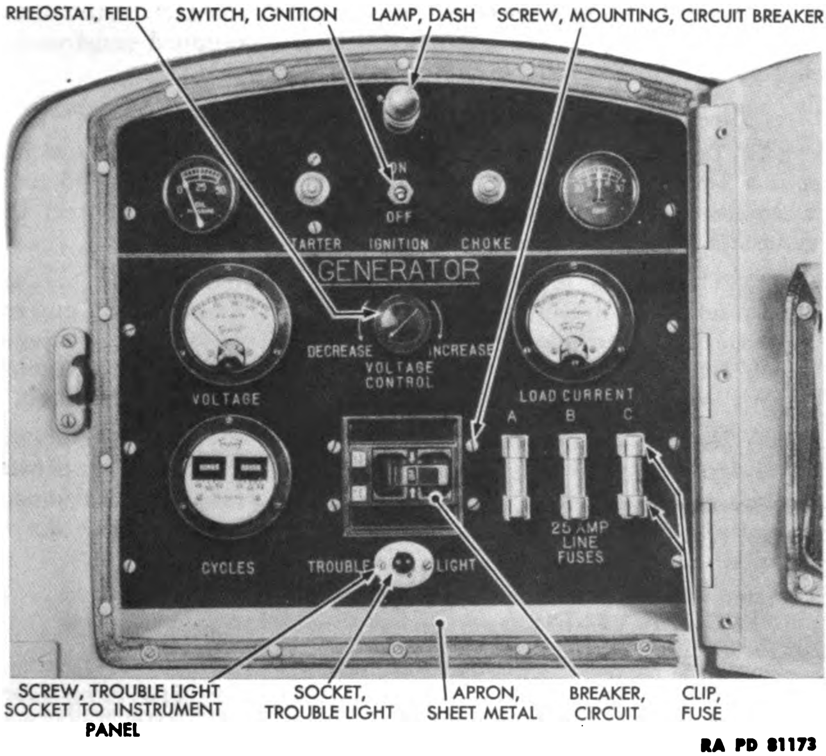


Figure 65 — Instrument Panel

b. Field Rheostat (Voltage Control).

(1) The field rheostat, labeled "voltage control" on the instrument panel, is an adjustable resistance unit. Its function is to allow manual adjustment of the voltage output of the main generator.

(2) A high-resistance wire is wound around a doughnut-shaped piece of porcelain. The knob controls a contact which slides around the inside of the coil. In this way, up to several feet of resistant wire can be introduced into the circuit to lower the voltage. When the field rheostat knob is turned clockwise as far as it will go, the rheostat wire is entirely eliminated from the circuit. This permits the maximum voltage output of the generator to flow through the lines from the unit. As the knob is turned counterclockwise, more and more resistant wire comes into the circuit. Consequently, the voltage falls.

c. Dash Lamp. Of standard automotive design, the dash lamp illuminates the instrument panel. It is turned on and off by built-in switch.

Section VII

INSTRUMENT PANEL

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INSTRUMENT PANEL

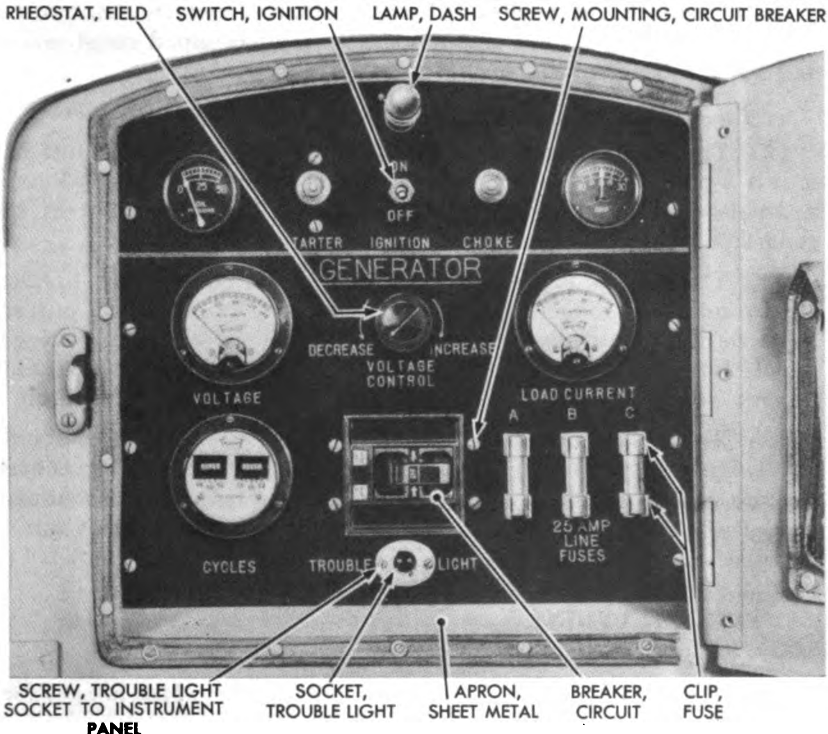

Figure 65 — Instrument Panel

b. Field Rheostat (Voltage Control).

(1) The field rheostat, labeled "voltage control" on the instrument panel, is an adjustable resistance unit. Its function is to allow manual adjustment of the voltage output of the main generator.

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c. Dash Lamp. Of standard automotive design, the dash lamp illuminates the instrument panel. It is turned on and off by built-in switch.

Section VII

INSTRUMENT PANEL

Paragraph

38. DESCRIPTION AND CONSTRUCTION.

a. Instrument Panel.

(1) Located at the rear of the unit, the instrument panel furnishes a consolidated location for the switches, fuses, and instruments of the unit (fig. 65). Grouped at the top are the engine instruments and controls. Included in this group are the oil pressure gage, starter switch, ignition switch, choke control, and battery charging generator ammeter. Grouped beneath the engine controls are the main generator instruments and controls. This group consists of an alternating-current voltmeter, field rheostat (voltage control), alternating-current ammeter, frequency meter, circuit breaker, and three fuses. At the extreme top center of the panel is a dash lamp. At the extreme bottom center is a trouble light socket.

(2) Constructed of Bakelite, the instrument panel is cut and drilled to receive all instruments and screws. Directive lettering to explain and identify the instruments is cut on the face of the panel. The lettering indentations are painted white to make the lettering more legible.

INSTRUMENT PANEL

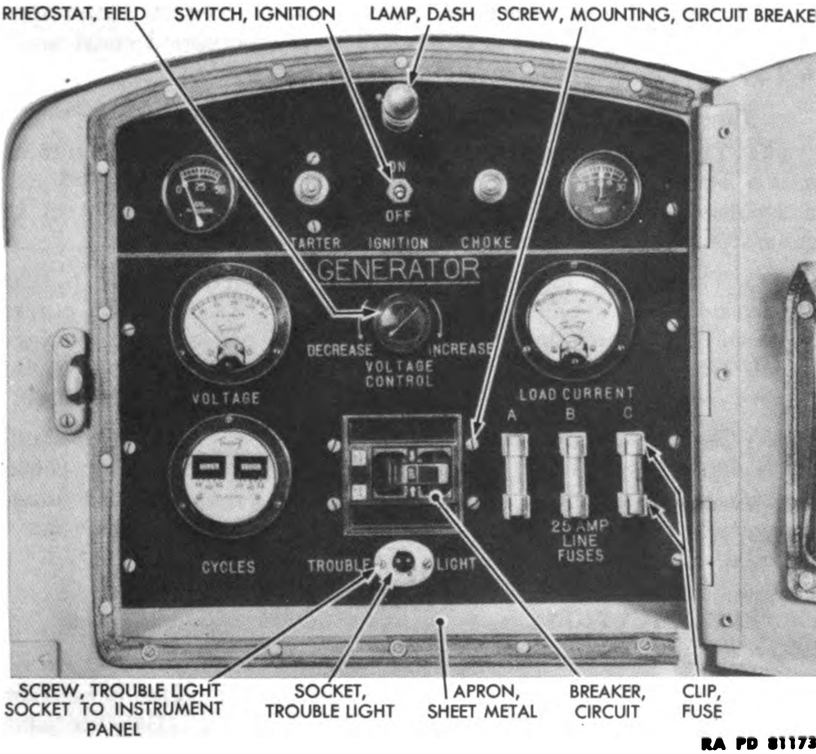


Figure 65 — Instrument Panel

b. Field Rheostat (Voltage Control).

(1) The field rheostat, labeled "voltage control" on the instrument panel, is an adjustable resistance unit. Its function is to allow manual adjustment of the voltage output of the main generator.

(2) A high-resistance wire is wound around a doughnut-shaped piece of porcelain. The knob controls a contact which slides around the inside of the coil. In this way, up to several feet of resistant wire can be introduced into the circuit to lower the voltage. When the field rheostat knob is turned clockwise as far as it will go, the rheostat wire is entirely eliminated from the circuit. This permits the maximum voltage output of the generator to flow through the lines from the unit. As the knob is turned counterclockwise, more and more resistant wire comes into the circuit. Consequently, the voltage falls.

c. Dash Lamp. Of standard automotive design, the dash lamp illuminates the instrument panel. It is turned on and off by built-in switch.

d. Trouble Light Socket. A simple, double contact, automotive-type trouble light socket is provided. It is of crimped construction and cannot be disassembled. No switch is provided.

e. Circuit Breaker.

(1) The circuit breaker serves a dual function. On the Unit M5 it is a 3-pole service switch for the main generator. Units M6 have a 2-pole circuit breaker. It is also a "safety valve" to protect the generator in case of an overload in the lines from the unit.

(2) Three coils (two on Units M6) within the circuit breaker create sufficient magnetism when an excessive amount of current flows through, to attract an iron lever. The lever serves as a trigger which, when drawn to the coil, allows springs to snap the switch off. An overload in any one of the three lines will trip the switch.

(3) Because of its extreme sensitiveness, the circuit breaker should be replaced as a unit if it fails to work properly. Special precision equipment is needed to disassemble and assemble the instrument properly. Improper tension on springs would throw the unit out of balance, and might result in considerable damage to the unit.

39. SPECIFICATIONS.

a. Instrument Panel.

Make .... Spaulding Fiber
Material .... Bakelite Corp.

b. Dash Lamp.

Make .... Cole-Hersee Co.
Model DL-5
Type .... d-c
Bulb .... 6 to 8 volts, 21 cp

c. Ignition Switch.

Make .... Arrow-Hart and Hegeman Electric Co.
Model 8963
Type .... Toggle

d. Circuit Breaker.

Make .... Heinemann Electric Co.
Model 0142
Type .... 2- or 3-pole
Voltage 125
Amperage 25

e. Trouble Light Socket.

Make .... Cole-Hersee Co.
Model 2036
Type .... d-c

INSTRUMENT PANEL

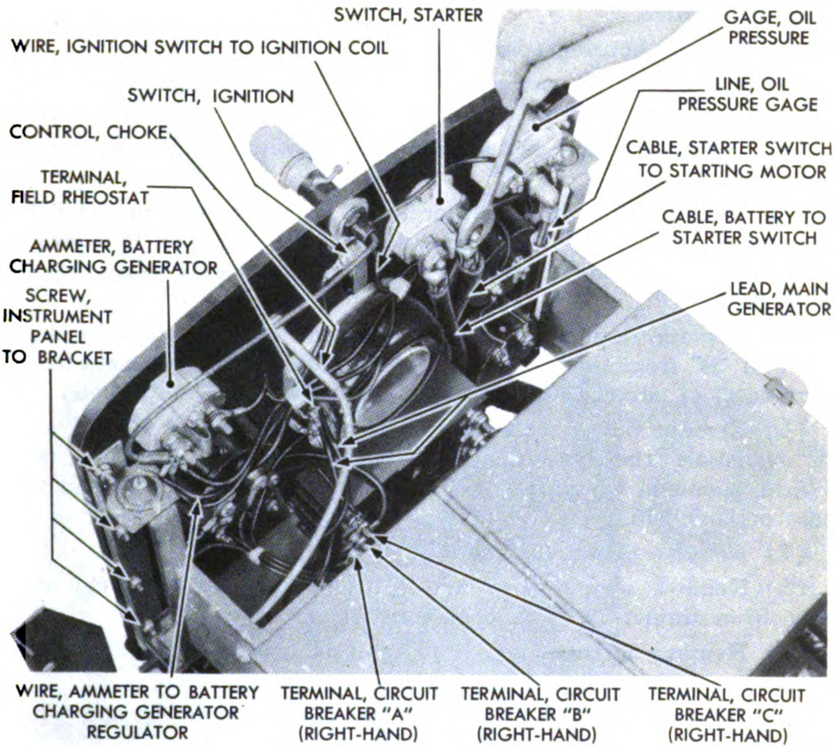


Figure 66 — Removing Instrument Panel

f. Field Rheostat.

Make	Hardwick-Hingle, Inc.
Model	D
Watt	150
Ohm	32

g. Fuses.

Make	Buss
Model	1014
Amperes	25
Volts	250

40. REMOVAL.

a. Equipment.

SCREWDRIVER
WRENCH, box, 3/8-in.
WRENCH, open-end, 5/16-in.
WRENCH, open-end, 3/8-in.
WRENCH, open-end, 7/16-in.
WRENCH, open-end, 1/2-in.
WRENCH, open-end, 9/16-in.

b. Procedure.

(1) Remove housing (par. 14).

(2) Disconnect oil pressure gage line from oil pressure gage (½-in. open-end wrench) (fig. 59).

(3) Disconnect both cables from starter switch (9/16-in. open-end wrench) (fig. 66).

(4) Disconnect main generator leads from top terminal of field rheostat of Unit M5 (5/16-in. open-end wrench) (fig. 66). Disconnect main generator leads from "M" posts on time delay relay on all Units M6.

(5) Remove duplex receptacle to circuit breaker wires marked "A" and "B" from terminals "A" and "B" (the two lower right-hand terminals) of circuit breaker (3/8-in. open-end wrench) (fig. 66).

(6) Remove outlet receptacle wires from terminals "A," "B," and "C" terminals (the three right-hand terminals) of the circuit breaker (3/8-in. open-end wrench) (fig. 70). This step does not apply in the case of Unit M6.

(7) Remove choke control (par. 154).

(8) Remove ammeter to battery charging generator regulator wire from ammeter (3/8-in. open-end wrench) (fig. 66).

(9) Remove ignition switch to ignition coil wire from ignition switch (screwdriver) (fig. 66).

(10) Disconnect wires from terminals "2," "RA," "RB," and "RC" (the center row) of change-over panel on Unit M5 (½-in. open-end wrench). On single and 3-phase Unit M6 disconnect wires from terminals "A," "B," and "C" of the middle row terminals on change-over panel. On single-phase Unit M6, disconnect wires from terminals "RA," "R5," and "R5A" on change-over panel.

(11) Remove instrument panel-to-bracket screws and safety nuts (3/8-in. box wrench and screwdriver) (fig. 66).

(12) Lift instrument panel from unit.

41. DISASSEMBLY.

a. Equipment.

PLIERS	WRENCH, open-end, 9/16-in.
SCREWDRIVER	WRENCH, open-end, 19/32-in.
WRENCH, open-end, 3/8-in.	WRENCH, open-end, 11/16-in.

b. Procedure.

(1) Remove oil pressure gage (par. 33).

(2) Remove battery charging generator ammeter (par. 34).

(3) Remove alternating-current voltmeter (par. 35).

(4) Remove alternating-current ammeter (par. 36).

(5) Remove frequency meter (par. 37).

INSTRUMENT PANEL

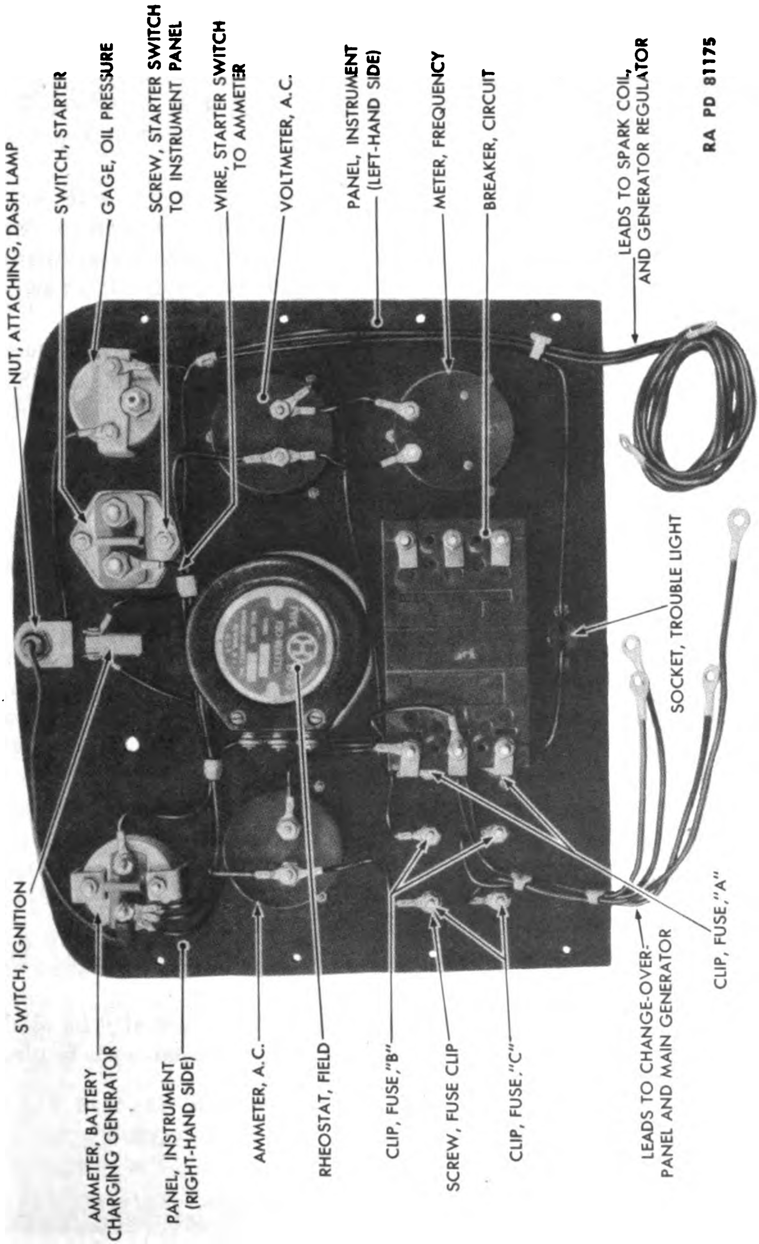


Figure 67 — Instrument Panel — Reverse Side

(6) Pull fuses from fuse clips. Remove fuse clip screws, nuts, flat washers, and lock washers (3/8-in. open-end wrench) (figs. 65 and 67). Lift fuse clips from switchboard panel.

(7) Remove dash lamp attaching nut lock washer, flat washer, ground wire terminal, and flat washer from rear of dash lamp. Lift dash lamp from instrument panel (19/32-in. open-end wrench) (figs. 65 and 67).

(8) Disconnect starter switch to ammeter wire from starter switch (9/16-in. open-end wrench) (fig. 67). Remove starter switch to instrument panel screws, nuts, lock washers, and flat washers (screwdriver and 3/8-in. open-end wrench) (fig. 67). Lift starter switch from switchboard panel.

(9) Remove ammeter to ignition switch wire from ignition switch (screwdriver) (fig. 67). Screw ferrule ring from ignition switch on face side of instrument panel (pliers) (fig. 65). Remove ignition switch mounting nut (11/16-in. open-end wrench) (fig. 65). Lift switch from instrument panel.

(10) Loosen setscrew in knob of field rheostat (voltage control) and pull knob from shaft (screwdriver) (fig. 65). Remove field rheostat attaching nut (9/16-in. open-end wrench) and pull field rheostat from reverse side of instrument panel.

(11) Remove circuit breaker mounting screws and washers from face of panel (screwdriver) (fig. 65). Lift circuit breaker from panel.

(12) Remove trouble light socket attaching screws (screwdriver) (fig. 65), nuts, and lock washers, and lift trouble light from instrument panel.

42. INSPECTION AND REPAIR.

a. Equipment.

COMPRESSED AIR
SOLVENT, dry-cleaning

b. Procedure.

(1) Wash instrument panel with SOLVENT, dry-cleaning. Dry with compressed air.

(2) Visually inspect panel for breakage. Look especially for slight cracks which collect dirt and act as conductors when wet. Replace instrument panel if broken.

43. ASSEMBLY.

a. Equipment.

PLIERS
SCREWDRIVER
WRENCH, open-end, 5/16-in.
WRENCH, open-end, 3/8-in.
WRENCH, open-end, 9/16-in.
WRENCH, open-end, 19/32-in.
WRENCH, open-end, 11/16-in.

b. Procedure.

(1) INSTALL INSTRUMENTS.

PLIERS	WRENCH, open-end, $\frac{9}{16}$-in.
SCREWDRIVER	WRENCH, open-end, $\frac{19}{32}$-in.
WRENCH, open-end, $\frac{3}{8}$-in.	WRENCH, open-end, $\frac{11}{16}$-in.

(a) Install oil pressure gage (par. 33).

(b) Install battery charging generator ammeter (par. 34).

(c) Install alternating-current voltmeter (par. 35).

(d) Install alternating-current ammeter (par. 36).

(e) Install frequency meter (par. 37).

(f) Place a fuse clip in position on panel (fig. 64). Insert a fuse clip screw through clip and panel. Install lock washer and nut (screwdriver and $\frac{3}{8}$-in. open-end wrench) (fig. 67). Repeat this step to install remaining five fuse clips.

(g) Place a flat washer on threaded end of dash lamp. Insert a lamp into its opening on top of panel. On base of lamp, install flat washer, ground wire terminal, flat washer, and dash lamp attaching nut ($\frac{19}{32}$-in. open-end wrench) (fig. 67).

(h) Place starter switch in position on panel and install screws, lock washers, and nuts (screwdriver and $\frac{3}{8}$-in. open-end wrench) (fig. 67).

(i) Place ignition switch in position from reverse side of panel. Install, on face side of panel, ignition switch mounting nut ($\frac{11}{16}$-in. open-end wrench) and ferrule ring (pliers) (fig. 65).

(j) Place field rheostat (voltage control) in position from reverse side of instrument panel (fig. 67). From face side, install field rheostat attaching nut ($\frac{9}{16}$-in. open-end wrench). Install field rheostat knob (screwdriver) (fig. 65).

(k) Place circuit breaker in position on reverse side of panel (fig. 67). From face of panel, install circuit breaker mounting screws and lock washers (screwdriver) (fig. 65).

(l) Place trouble light socket in position. Install screws, lock washers, and nuts (screwdriver and $\frac{3}{8}$-in. open-end wrench) (figs. 65 and 67).

(2) INSTALL WIRING.

SCREWDRIVER	WRENCH, open-end, $\frac{3}{8}$-in.
WRENCH, open-end, $\frac{5}{16}$-in.	WRENCH, open-end, $\frac{9}{16}$-in.

(a) On right-hand terminal (next to edge of instrument panel) of battery charging generator ammeter, install ammeter-to-trouble-lamp-socket wire, ammeter-to-battery-charging-generator-regulator wire, ammeter-to-ignition-switch wire, ammeter-to-dash-lamp wire, lock washer, and nut ($\frac{3}{8}$-in. open-end wrench) (fig. 67).

(b) On left-hand terminal (next to ignition switch) of battery charging generator ammeter, install the starter-switch-to-ammeter wire, lock washer, and nut (3/8-in. open-end wrench) (fig. 67).

(c) On right-hand terminal (next to ammeter) of ignition switch, install ammeter-to-ignition-switch wire, lock washer, and screw (screwdriver) (fig. 67).

(d) On left-hand terminal (next to starter switch) of ignition switch, install ignition-switch-to-coil wire, lock washer, and screw (screwdriver) (fig. 67).

(e) On oil pressure gage right-hand mounting stud, install dash lamp ground wire under the lock washer (3/8-in. open-end wrench) (fig. 67).

(f) On right-hand terminal (next to ignition switch) of starter switch, install starter-switch-to-ammeter wire beneath the washer (9/16-in. open-end wrench) (fig. 67).

(g) On oil pressure gage left-hand mounting stud, install trouble lamp socket ground wire under lock washer (3/8-in. open-end wrench) (fig. 67).

(h) On right-hand terminal (next to edge of instrument panel) of alternating-current ammeter, install alternating-current ammeter to voltmeter wire, alternating-current ammeter to fuse "C" ("5A" on single-phase Unit M6) wire, lock washer, and nut (3/8-in. open-end wrench) (fig. 67).

(i) On left-hand terminal (next to field rheostat) of alternating-current ammeter, install alternating-current ammeter to circuit breaker wire, lock washer, and nut (3/8-in. open-end wrench) (fig. 67).

(j) Connect Field Rheostat.

1. Unit M5. To the two lower terminals of field rheostat (voltage control), connect the two terminals on one end of change-over panel "1" wire (5/16-in. open-end wrench) (figs. 67 and 72).

2. Single- and 3-phase Unit M6. Connect the wire from the resistor in the exciter field to the two lower terminals of the field rheostat.

3. Single-phase Unit M6. Connect the wire from terminal "4" on change-over panel to the two lower terminals of the field rheostat.

(k) On right-hand terminal (next to field rheostat) of alternating-current voltmeter, install alternating-current ammeter-to-voltmeter wire, right-hand frequency-meter-to-voltmeter wire, lock washer, and nut (3/8-in. open-end wrench) (fig. 67).

(l) On left-hand terminal (next to edge of instrument panel) of alternating-current voltmeter, install left-hand frequency-meter-to-voltmeter wire, voltmeter-to-"A" ("4" on single-phase Unit M6) fuse wire, lock washer, and nut (3/8-in. open-end wrench) (fig. 67).

(m) On left-hand terminal (next to edge of instrument panel) of frequency meter, install left-hand frequency-meter-to-voltmeter wire, lock washer, and nut (3/8-in. open-end wrench) (fig. 67). On Units M6 the voltmeter-to-fuse-"A" or "4" (as the case may be) wire must also be installed on this terminal.

(n) On right-hand terminal (next to circuit breaker) of frequency meter, install right-hand frequency-meter-to-voltmeter wire, lock washer, and nut (3/8-in. open-end wrench) (fig. 67).

(o) On top right terminal (next to fuses) of circuit breaker, install alternating-current ammeter-to-circuit-breaker wire, flat washer, tag marked "C," lock washer, and nut (3/8-in. open-end wrench) (fig. 67).

(p) On middle right-hand terminal (next to fuses) of circuit breaker, install circuit-breaker-to-fuse-"B" wire, flat washer, tag marked "B," lock washer, and nut (3/8-in. open-end wrench) (fig. 67). Omit this step when repairing the single-phase Unit M6.

(q) On lower right-hand terminal (next to fuses) of circuit breaker, install circuit-breaker-to-fuse-"A" ("4" on single-phase Unit M6) wire, flat washer, clip marked "A," lock washer, and nut (3/8-in. open-end wrench) (fig. 67).

(r) On terminal of top clip of fuse "A" ("4" on single-phase Unit M6), install flat washer, voltmeter-to-fuse-"A" wire, circuit-breaker-to-fuse-"A" wire, flat washer, lock washer, and nut (3/8-in. open-end wrench) (fig. 67).

(s) On terminal of top clip of fuse "B," install flat washer, circuit-breaker-to-fuse-"B" wire, flat washer, lock washer, and nut (3/8-in. open-end wrench) (fig. 67). Omit this step on single-phase Unit M6.

(t) On terminal of top clip of fuse "C" ("5A" on single-phase Unit M6), install flat washer, alternating-current ammeter-to-fuse-"C" ("5A" on single-phase Unit M6) wire, flat washer, lock washer, and nut (3/8-in. open-end wrench) (fig. 67).

(u) Connect Fuses.

1. Unit M5. On terminal of bottom clip of fuse "A," install flat washer, fuse-"A"-to-change-over-panel-"RA" wire, flat washer, lock washer, and nut (3/8-in. open-end wrench) (fig. 67). On terminal of bottom clip of fuse "B," install flat washer, fuse-"B"-to-change-over-panel-"RB" wire, flat washer, lock washer, and nut (3/8-in. open-end wrench) (fig. 67). On terminal of bottom clip of fuse "C," install flat washer, fuse-"C"-to-change-over-panel-"RC" wire, flat washer, lock washer, and nut (3/8-in. open-end wrench) (fig. 67).

2. Single- and 3-phase Unit M6. On terminal of bottom clip of fuse "A," install flat washer, main generator lead "A" wire, flat washer, lock washer, and nut. On terminal of bottom clip of fuse "B," install flat washer, main generator lead "B," flat washer, lock washer, and

nut. On bottom clip of fuse "C," install flat washer, main generator lead "C," flat washer, lock washer, and nut.

3. Single-phase Unit M6. On terminal of bottom clip of fuse "4," install flat washer, fuse "4"-to-change-over-panel-"RA" wire, flat washer, lock washer, and nut. On terminal of bottom clip of fuse "5," install flat washer, fuse "5" to change-over panel "R5" wire, flat washer, lock washer, and nut. On terminal of bottom clip of fuse "5A," install flat washer, fuse-"5A"-to-change-over-panel-"R5A" wire, flat washer, lock washer, and nut.

(v) Connect trouble light socket ground wire and ammeter-to-trouble-light-socket wire, to trouble light socket (screwdriver) (fig. 67).

44. INSTALLATION.

a. Equipment.

SCREWDRIVER
WRENCH, box, 3/8-in.
WRENCH, open-end, 5/16-in.
WRENCH, open-end, 3/8-in.
WRENCH, open-end, 7/16-in.
WRENCH, open-end, 1/2-in.
WRENCH, open-end, 9/16-in.

b. Procedure.

(1) Place instrument panel in position on brackets. Install attaching screws and safety nuts (3/8-in. box wrench and screwdriver) (fig. 66).

(2) CONNECT FIELD RHEOSTAT WIRES.

(a) Unit M5. Connect field rheostat-to-change-over-panel "1" wire to terminal marked "1" on change-over panel. Install lock washer and nut (7/16-in. open-end wrench) (fig. 72).

(b) Single- and 3-phase Unit M6. Connect field rheostat-to-resistor wire to resistor in field circuit.

(c) Single-phase Unit M6. Connect field rheostat-to-change-over-panel-"3" wire to change-over panel terminal "3."

(3) CONNECT FUSE WIRES.

(a) Unit M5. Connect fuse-"A"-to-change-over-panel-"RA" wire, to change-over panel terminal "RA." Install lock washer and nut (7/16-in. open-end wrench) (fig. 72). Connect fuse-"B"-to-change-over-panel-"RB" wire, to change-over panel terminal "RB." Install lock washer and nut (7/16-in. open-end wrench) (fig. 72). Connect fuse-"C"-to-change-over-panel-"RC" wire, to change-over panel terminal "RC." Install lock washer and nut (7/16-in. open-end wrench) (fig. 72).

(b) Single- and 3-phase Unit M6. Connect circuit breaker-to-change-over-panel wire, marked "A," "B," and "C," to corresponding terminals in middle row on change-over panel.

(c) Single-phase Unit M6. Connect fuse-"4"-to-change-over-panel-"RA" wire, to terminal "RA" of change-over panel. Connect fuse "5" to change-over panel "R5" on change-over panel. Connect fuse-"5A"-to-change-over-panel-"R5A" wire, to change-over panel terminal "R5A."

(4) Connect ammeter-to-battery-charging-generator-regulator wire, to right-hand terminal (next to edge of instrument panel) of battery charging generator ammeter (3/8-in. open-end wrench) (fig. 66).

(5) Connect ignition switch to ignition coil wire, to left-hand terminal (next to starter switch) of ignition switch (screwdriver) (fig. 66).

(6) Install choke control (par. 154).

(7) CONNECT DUPLEX RECEPTACLE.

(a) Unit M5. Connect the two duplex receptacle to circuit breaker wires marked "A" and "B," to the terminals marked "A" and "B" (the two lower right-hand terminals of circuit breaker, respectively) (3/8-in. open-end wrench) (fig. 66).

(b) Single- and 3-phase Unit M6. Connect the two duplex receptacles to circuit breaker wires marked "A" and "B" to the terminals marked "A" and "B."

(8) Connect unmarked main generator leads which come from exciter bearing bracket, to top terminal of field rheostat (5/16-in. open-end wrench).

(9) Connect battery starter switch cable to right-hand terminal (next to ignition switch) of starter switch (9/16-in. open-end wrench) (fig. 66).

(10) Connect starter-switch-to-starting-motor-cable, to left-hand terminal (next to oil pressure gage) of starter switch (9/16-in. open-end wrench) (fig. 66).

(11) Connect oil pressure gage line to gage (1/2-in. open-end wrench) (fig. 66).

(12) Install housing (par. 19).

45. FIELD RHEOSTAT REMOVAL.

a. Equipment.

SCREWDRIVER	WRENCH, open-end, 3/8-in.
WRENCH, open-end, 5/16-in.	WRENCH, open-end, 9/16-in.

b. Procedure.

(1) From top terminal of field rheostat, remove nut, two main generator leads, and shakeproof terminal lug (5/16-in. open-end wrench) (fig. 67).

(2) From each lower terminal of field rheostat, remove nut, field rheostat-to-change-over-panel-"2" wire, and shakeproof terminal lug (3/8-in. open-end wrench) (fig. 67).

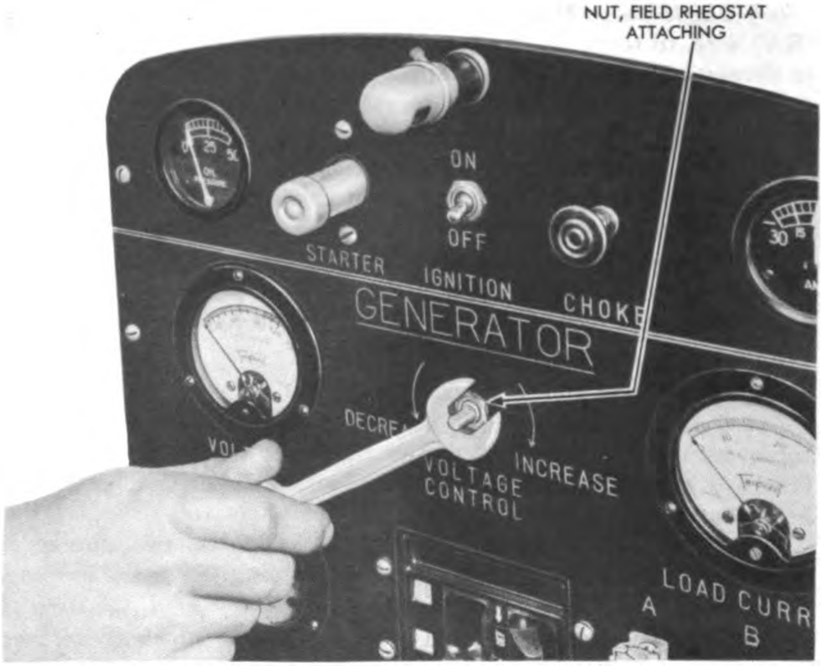


Figure 68 — Removing Field Rheostat

(3) Loosen setscrew in field rheostat knob and remove knob (screwdriver) (fig. 65).

(4) Remove field rheostat attaching nut ($\frac{9}{16}$-in. open-end wrench) (fig. 68).

(5) Lift field rheostat from reverse side of instrument panel.

46. FIELD RHEOSTAT INSPECTION AND REPAIR.

a. Equipment.

LAMP, test — PLIERS

b. Procedure.

(1) Visually inspect the porcelain of winding form assembly for fractures. Replace assembly if broken.

(2) Test winding of the winding form for an open circuit with a test lamp. Place probes of test lamp about an inch apart on windings on the part kept shiny by contact. Make several tests around winding so that all parts of winding are tested. If lamp fails to glow on any of the trials, an open circuit is indicated. Replace assembly if it has an open circuit.

(3) Examine all screws, nuts, and lock washers. Replace any that are broken or have damaged threads.

INSTRUMENT PANEL

47. FIELD RHEOSTAT INSTALLATION.

a. Equipment.

SCREWDRIVER — WRENCH, open-end, 3/8-in.
WRENCH, open-end, 5/16-in. — WRENCH, open-end, 9/16-in.

b. Procedure.

(1) Place field rheostat in position on reverse side of instrument panel, with shaft through hole in panel (fig. 67).

(2) Install field rheostat attaching nut (9/16-in. open-end wrench) (fig. 68).

(3) Slide knob on shaft and tighten setscrew (screwdriver) (fig. 65).

(4) On each lower terminal of the field rheostat, install a shakeproof terminal lug, field rheostat-to-change-over-panel-"2" wire, and nut (3/8-in. open-end wrench) (fig. 67).

(5) On top terminal of field rheostat, place a shakeproof terminal lug and the unmarked main generator leads coming from exciter bearing bracket. Install the nut (5/16-in. open-end wrench) (fig. 67).

48. DASH LAMP AND TROUBLE LIGHT SOCKET REMOVAL.

a. Equipment.

SCREWDRIVER — WRENCH, open-end, 5/8-in.
WRENCH, open-end, 3/8-in.

b. Procedure.

(1) Remove Dash Lamp.

WRENCH, open-end, 3/8-in. — WRENCH, open-end, 5/8-in.

(a) Disconnect wire from right-hand terminal of battery charging generator ammeter (3/8-in. open-end wrench) (fig. 67).

(b) Remove dash lamp mounting nut from base of dash lamp (5/8-in. open-end wrench) (fig. 67), and remove flat washer, ground wire terminal, and flat washer (fig. 67).

(c) Pull dash lamp from face of instrument panel, and remove spacer and flat washer from base of lamp (fig. 65).

(2) Remove Trouble Light Socket.

SCREWDRIVER — WRENCH, open-end, 3/8-in.

(a) Disconnect trouble light socket wire from right-hand terminal of battery charging generator ammeter (3/8-in. open-end wrench) (fig. 67).

(b) Disconnect trouble light socket ground wire from left-hand oil pressure gage mounting screw (3/8-in. open-end wrench) (fig. 67).

(c) Remove socket screws and nuts (screwdriver and 3/8-in. open-end wrench) (fig. 67).

(d) Pull trouble light socket from instrument panel.

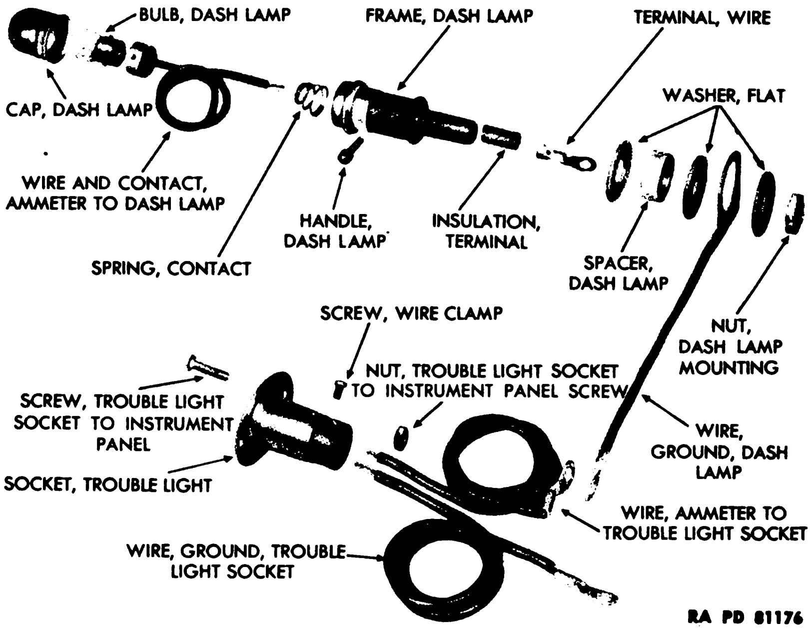


Figure 69 — Dash Lamp and Trouble Light Socket Assemblies — Exploded View

49. DASH LAMP AND TROUBLE LIGHT SOCKET DISASSEMBLY.

a. Equipment.

IRON, soldering — SCREWDRIVER
PLIERS

b. Procedure.

(1) DISASSEMBLE DASH LAMP.

IRON, soldering — PLIERS

(a) Pull dash lamp cap from frame of lamp (fig. 69).

(b) Turn bulb one-eighth turn counterclockwise and pull from socket (fig. 69).

(c) Screw dash lamp handle from contact (pliers) (fig. 69).

(d) Push wire and contact from frame (fig. 69).

(e) Push terminal insulation up on wire, and disconnect terminal from wire (soldering iron) (fig. 69).

(f) Pull wire and contact, and contact spring, from frame (fig. 69).

(2) DISASSEMBLE TROUBLE LIGHT SOCKET.

SCREWDRIVER

(a) Loosen the wire clamp screws (screwdriver) (fig. 69).

(b) Pull wires from socket.

50. DASH LAMP AND TROUBLE LIGHT SOCKET INSPECTION AND REPAIR.

a. Equipment.

CLOTH, abrasive, aluminum-oxide
COMPRESSED AIR
FILE, fine mill
SOLDERING EQUIPMENT
SOLVENT, dry-cleaning

b. Procedure.

(1) Clean all metal parts in an approved SOLVENT, dry-cleaning, and dry with compressed air.

(2) Clean terminals and contact points with CLOTH, abrasive, aluminum-oxide.

(3) Examine insulation of wires. Replace if worn, broken, or badly weathered.

(4) Examine all metal parts. Replace if bent or broken.

(5) Examine all threads on frame, screws, and nuts. Replace parts having badly damaged threads. Remove burs from threads with a fine mill file.

(6) Examine contact points. Build up with solder if worn (soldering equipment).

(7) Examine fiber blocks containing contact points. Replace if broken.

51. DASH LAMP AND TROUBLE LIGHT SOCKET ASSEMBLY.

a. Equipment.

PLIERS
SCREWDRIVER
SOLDERING EQUIPMENT

b. Procedure.

(1) ASSEMBLE DASH LAMP.

PLIERS SOLDERING EQUIPMENT

(a) Slide contact spring, small end first, on ammeter to dash lamp wire. Thread wire through large end of frame (fig. 69).

(b) Screw dash lamp handle into the contact through its opening in frame (pliers) (fig. 69).

(c) Slide terminal insulation on end of ammeter to dash lamp wire. Solder terminal to tip of wire (soldering equipment) (fig. 69). Pull insulation down over connection.

(d) Insert bulb in socket and turn one-eighth turn clockwise.

(e) Push cap on end of frame.

(2) ASSEMBLE TROUBLE LIGHT.

SCREWDRIVER

(a) Insert bare ends of wires into their openings on trouble light socket. Install wire clamp screws (screwdriver) (fig. 69).

52. DASH LAMP AND TROUBLE LIGHT SOCKET INSTALLATION.

a. Equipment.

SCREWDRIVER — WRENCH, open-end, 5/8-in.
WRENCH, open-end, 3/8-in.

b. Procedure.

(1) INSTALL DASH LAMP.

WRENCH, open-end, 3/8-in. — WRENCH, open-end, 5/8-in.

(a) Place a flat washer and spacer on threaded end of frame (fig. 69).

(b) Insert dash lamp through its opening in instrument panel (fig. 65).

(c) On the threaded end of dash lamp install a flat washer, dash lamp ground wire terminal, flat washer, and dash lamp mounting nut (5/8-in. open-end wrench) (fig. 67).

(d) Connect ammeter-to-dash-lamp wire to right-hand terminal (next to edge of instrument panel) of battery charging generator ammeter (3/8-in. open-end wrench) (fig. 67).

(2) INSTALL TROUBLE LIGHT SOCKET.

SCREWDRIVER — WRENCH, open-end, 3/8-in.

(a) Place trouble light socket in position on instrument panel (fig. 65).

(b) Install two screws and nuts (screwdriver and 3/8-in. open-end wrench) (fig. 65).

(c) Connect ammeter-to-trouble-light-socket wire, to right-hand terminal (next to edge of panel) of battery charging generator ammeter (3/8-in. open-end wrench) (fig. 67).

(d) Connect trouble light socket ground wire to left-hand oil pressure gage mounting screw (screwdriver) (fig. 67).

53. IGNITION SWITCH.

a. Removal.

PLIERS — WRENCH, open-end, 9/16-in.
SCREWDRIVER

(1) Disconnect ammeter wire from ignition switch (screwdriver) (fig. 67).

(2) Disconnect coil wire from ignition switch (screwdriver) (fig. 67).

(3) Remove ignition switch lock nut (pliers) (fig. 65) and ignition switch mounting nut (9/16-in. open-end wrench) (fig. 65) from face of instrument panel.

(4) Lift ignition switch from reverse side of panel (fig. 67).

INSTRUMENT PANEL

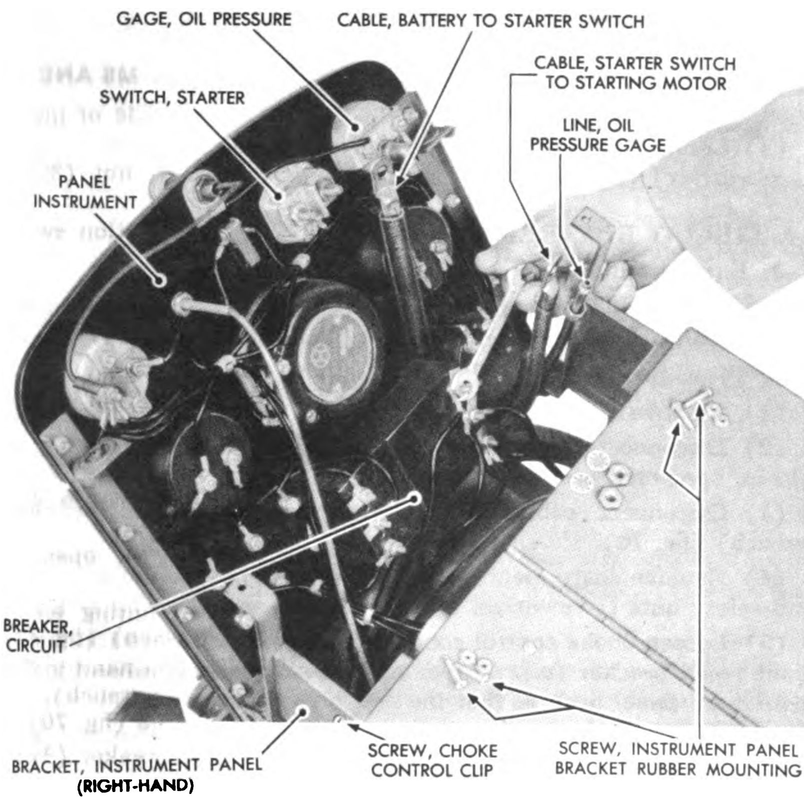


Figure 70 — Removing Circuit Breaker

b. Inspection and Repair.

CLOTH, abrasive, aluminum-oxide
FILE, fine mill
LAMP, test

(1) Clean terminals with CLOTH, abrasive, aluminum-oxide.

(2) Turn switch on and test for continuity of circuit with a test lamp. Place test lamp probes on two terminals of switch. If lamp fails to light, replace switch.

(3) Repeat step (1) above with switch turned off. If lamp lights, replace switch.

(4) Examine threads on switch. Remove burs with a fine mill file. Replace switch if threads are stripped.

c. Installation.

PLIERS
SCREWDRIVER
WRENCH, open-end, $\frac{9}{16}$-in.

(1) Place ignition switch in position from reverse side of instrument panel (fig. 67).

(2) Install ignition switch mounting nut and lock nut (9/16-in. open-end wrench and pliers) (fig. 65).

(3) Connect ammeter and ignition coil wires to ignition switch (screwdriver) (fig. 67).

54. CIRCUIT BREAKER REMOVAL.

a. Equipment.

SCREWDRIVER
WRENCH, open-end, 3/8-in.
WRENCH, open-end, 1/2-in.
WRENCH, open-end, 9/16-in.

b. Procedure.

(1) Remove housing (par. 14).

(2) Disconnect oil pressure gage line, from oil pressure gage (1/2-in. open-end wrench) (fig. 70).

(3) Disconnect cables from starter switch (9/16-in. open-end wrench) (fig. 70).

(4) Remove instrument panel bracket rubber mounting screws and safety nuts (screwdriver and 3/8-in. open-end wrench) (fig. 70).

(5) Loosen choke control conduit clip screw on right-hand instrument panel bracket (screwdriver and 1/2-in. open-end wrench). Tip instrument panel back so that the rear side is accessible (fig. 70).

(6) Disconnect all wires from terminals of circuit breaker (3/8-in. open-end wrench) (fig. 70). Tag wires to aid installation.

(7) Remove circuit breaker mounting screws and lock washers from face of instrument panel (screwdriver) (fig. 65).

(8) Lift circuit breaker from panel (fig. 70).

55. CIRCUIT BREAKER INSPECTION.

a. Equipment.

LAMP, test

b. Procedure.

(1) No attempt should be made to disassemble and repair circuit breaker. Special equipment is needed for the job. Replace assembly if it fails to function properly.

(2) STEPS IN TESTING THE CIRCUIT BREAKER.

LAMP, test

(a) Examine case and handle. Replace circuit breaker if these parts are broken.

(b) With circuit breaker turned on, test for continuity of circuit (test lamp) between the top terminals (one on each side). Repeat test on the middle terminals and then on the lower terminals. Omit

test on middle terminals on single-phase Unit M6 having 2-pole circuit breaker. Replace circuit breaker if lamp fails to light on any test.

(c) From a measured variable source of alternating 50- or 60-cycle current, attach leads to top terminals (one on each side) of circuit breaker. With circuit breaker in "ON" position, step current up to 50 amperes, 125 volts, and allow circuit breaker to trip to "OFF" position. Reset circuit breaker to "ON" position, and measure the time interval required for it to trip to "OFF" position. With a 50-ampere load at 125 volts, it should trip in no less than 6 seconds and no more than 25 seconds, after it has been reset to "ON" position. Repeat this test on the middle and the lower terminals of the circuit breaker. Omit test on middle terminals on single-phase Unit M6 having 2-pole circuit breaker. Replace circuit breaker if it fails to function properly.

56. CIRCUIT BREAKER INSTALLATION.

a. Equipment.

SCREWDRIVER	WRENCH, open-end, ½-in.
WRENCH, open-end, ⅜-in.	WRENCH, open-end, 9/16-in.

b. Procedure.

(1) Place circuit breaker in position on reverse side of instrument panel (fig. 70). Be sure handle points toward the fuses when off. Install circuit breaker mounting screws and lock washers (screwdriver) (fig. 65).

(2) UNIT M5.

(a) On top left-hand terminal (next to frequency meter) of circuit breaker, install flat washer, tag marked "C," circuit breaker to outlet receptacle wire marked "C," flat washer, lock washer, and nut (⅜-in. open-end wrench) (fig. 70).

(b) On middle left-hand terminal (next to frequency meter) of circuit breaker, install flat washer, tag marked "B," circuit breaker to outlet receptacle wire marked "B," circuit breaker to duplex receptacle wire marked "B," flat washer, lock washer, and nut (⅜-in. open-end wrench) (fig. 70).

(c) On lower left-hand terminal (next to frequency meter) of circuit breaker, install flat washer, tag marked "A," circuit breaker to duplex receptacle wire marked "A," flat washer, lock washer, and nut (⅜-in. open-end wrench)(fig. 70).

(d) On top right-hand terminal (next to fuses) of circuit breaker, install flat washer, tag marked "C," alternating-current ammeter to circuit breaker wire, flat washer, and nut (⅜-in. open-end wrench) (fig. 70).

(e) On middle top right-hand terminal (next to fuses) of circuit breaker, install flat washer, tag marked "B," circuit breaker to fuse "B" wire, flat washer, lock washer, and nut (3/8-in. open-end wrench) (fig. 70).

(f) On lower right-hand terminal (next to fuses) of circuit breaker, install flat washer, tag marked "A," circuit breaker to fuse "A" wire, flat washer, lock washer, and nut (3/8-in. open-end wrench) (fig. 70).

(3) SINGLE-PHASE UNIT M6.

(a) On top left-hand terminal of circuit breaker install flat washer, tag marked "5A," circuit breaker to time delay relay wire "5A," circuit breaker to panel condenser wire marked "5A".

(b) On lower left-hand terminal, install tag marked "4," circuit breaker to time delay relay "4" wire, tag marked "4," circuit breaker to panel condenser wire marked "4".

(c) On lower left-hand terminal, install tag marked "5A," and alternating-current ammeter to circuit breaker wire.

(d) On lower right-hand terminal, install tag marked "4," circuit breaker to fuse "4" wire.

(4) SINGLE- AND 3-PHASE M6 UNIT.

(a) On top left-hand terminal of circuit breaker tag marked "C," install circuit breaker to change-over panel wire marked "O".

(b) On middle left-hand terminal of circuit breaker, install tag marked "B," circuit breaker to change-over panel wire marked "B".

(c) On lower left-hand terminal, install tag marked "A," circuit breaker to change-over panel wire marked "1".

(d) Follow steps *(d)*, *(e)*, and *(f)* in (2) above.

(5) Lift instrument panel into position on bracket, and install mounting screws (screwdriver and 3/8-in. open-end wrench) (fig. 70).

(6) Connect cables to starter switch (9/16-in. open-end wrench) (fig. 70).

(7) Connect oil pressure gage line to oil pressure gage (1/2-in. open-end wrench) (fig. 70).

(8) Insert choke control under clip on right-hand instrument panel bracket. Tighten choke control clip screw (screwdriver) (fig. 70).

(9) Install housing (par. 19).

Section VIII

CHANGE-OVER PANEL, TOOL BOX, AND RECEPTACLES

57. DESCRIPTION AND CONSTRUCTION.

a. Change-over Panel.

(1) Located in a compartment in the right-hand end of the tool box, the change-over panel provides the means of changing the Unit M5 from 60-cycle to 50-cycle. In the Unit M6, the change-over panel enables unit to be converted from 3-phase to single-phase, except on units bearing serial numbers 1 to 266 and 367 to 376, inclusive.

(2) The change-over panel consists of a Bakelite plate with binding posts mounted on it, to receive the change-over bars. The manner in which the change-over bars are connected determines the frequency, or the phase, of the current output of the generator.

b. Tool Box. Constructed of sheet steel, the tool box is located on top of the main generator. It is equipped with two doors. The left-hand door gives access to the tool compartment. The right-hand door gives access to the change-over panel.

c. Duplex Receptacle.

(1) On the M5 model, a duplex outlet receptacle is provided. It is located on the left side of the unit beneath the tool box and is similar to standard outlet receptacles used in homes. It provides a convenient method of taking power from the generator to operate standard 110-volt, alternating-current lights or appliances. Two plugs can be inserted at the same time.

(2) Because of its riveted and molded construction, disassembly of the duplex receptacle is impractical. Replace the assembly in case of failure.

d. The 3-pole Outlet Receptacle.

(1) All Units M5 and some Units M6 are equipped with a 3-pole outlet receptacle located on the rear of the unit below the instrument panel. The body of the outlet receptacle is brass, and is threaded

to receive a brass cover. A Bakelite insulator held inside the body by a split ring holds the contacts in position.

(2) This receptacle provides the means of connecting power lines to take off the current generated by the unit.

e. The 19-pole Outlet Receptacle.

(1) The 19-pole outlet receptacle used on all Units M6 is similar in construction and function to the 3-pole unit described above. The difference is that one has 19 contacts and 19 wires while the other has three.

58. SPECIFICATIONS.

a. Change-over Panel.

Make	Spaulding Fiber
Material	Bakelite Corp.
Size (M5)	5½ x 8 in.
Size (M6)	8 x 5 in.
Number of binding posts (M5)	12
Number of binding posts (M6)	8
Number of change-over bars (M5)	4
Number of change-over bars (M6)	3

b. Tool Box.

Make	The Hobart Bros. Co.
Material	Sheet steel
Construction	Welded

c. Duplex Receptacle.

Make	Hobart Mfg. Co.
Model	M19951
Type	Double contact
Number of sockets	2

d. 3-pole Outlet Receptacle.

Make	Hobart Mfg. Co.
Model	P19416

e. 19-pole Outlet Receptacle.

Make	The Pyle-National Company
Model	C56703

59. CHANGE-OVER PANEL.

a. Removal (fig. 71).

SCREWDRIVER
WRENCH, open-end, ½-in.
WRENCH, open-end, 7/16-in.

(1) Disconnect all wires from binding posts on rear of change-over panel (7/16-in. open-end wrench) (fig. 71). Lift resistor from rear of binding posts "1" and "2."

CHANGE-OVER PANEL, TOOL BOX, AND RECEPTACLES

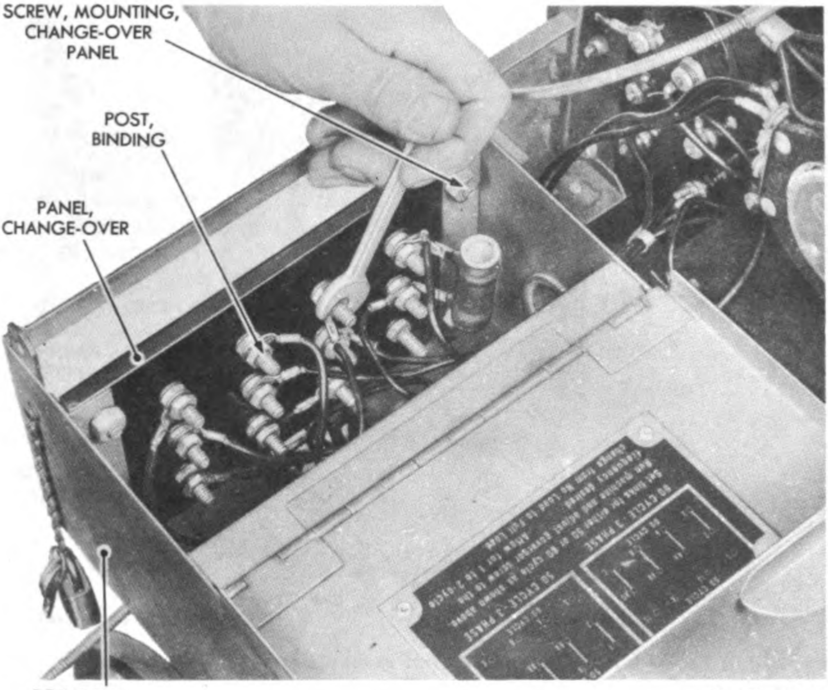


Figure 71 — Removing Change-over Panel

(2) Remove change-over panel mounting screws, nuts, and lock washers (screwdriver and ½-in. open-end wrench) (fig. 71).

(3) Lift change-over panel from tool box (fig. 71).

b. Disassembly.

WRENCH, open-end, ½-in. (2)

(1) Remove nuts, change-over bars, and lock washers from binding posts (two ½-in. open-end wrenches) (fig. 72). Lift binding posts from change-over panel.

c. Inspection and Repair.

CLOTH, abrasive, aluminum-oxide
COMPRESSED AIR
FILE, fine mill
SOLVENT, dry-cleaning

(1) Wash change-over panel, binding posts, change-over bars, lock washers, and nuts (SOLVENT dry-cleaning) and dry (COMPRESSED AIR). Clean corrosion from metal parts (CLOTH, abrasive, aluminum-oxide).

(2) Carefully inspect change-over panel to detect any cracks which might harbor dirt. Dirt acts as a conductor when damp. Replace change-over panel if fractured.

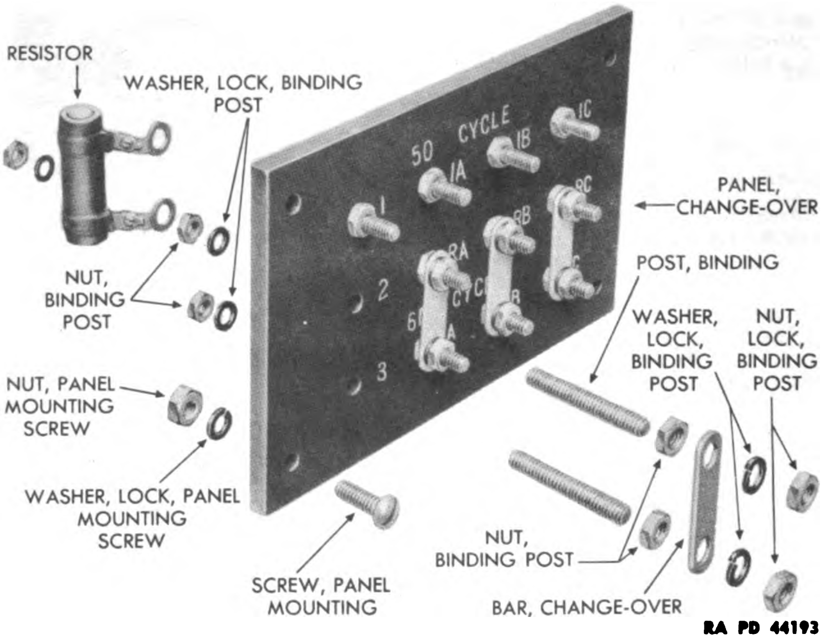


Figure 72 — Change-over Panel Assembly — Exploded View

(3) Inspect all metal parts to see if any are bent or broken. Replace unserviceable parts.

(4) Inspect threads of binding posts and nuts. Remove burs (fine mill file).

d. Assembly.

WRENCH, open-end, ½-in. (2)

(1) Insert binding post about half its length through a binding post hole in change-over panel (fig. 72).

(2) Screw a nut up to face of change-over panel. On the reverse side, install a lock washer and nut (two ½-in. open-end wrenches).

(3) Repeat steps (1) and (2) above to install remaining binding posts. NOTE: There are 12 binding posts on the Unit M5; eight on the Units M6 with serial numbers 1 to 266 and 367 to 376, inclusive. Other Units M6 have 12 binding posts on the change-over panel.

e. Installation.

SCREWDRIVER **WRENCH,** open-end, ½-in.

WRENCH, open-end, 7/16-in.

(1) Place change-over panel in position in right-hand end of tool box. Install mounting screws, lock washers, and nuts (screwdriver and ½-in. open-end wrench).

CHANGE-OVER PANEL, TOOL BOX, AND RECEPTACLES

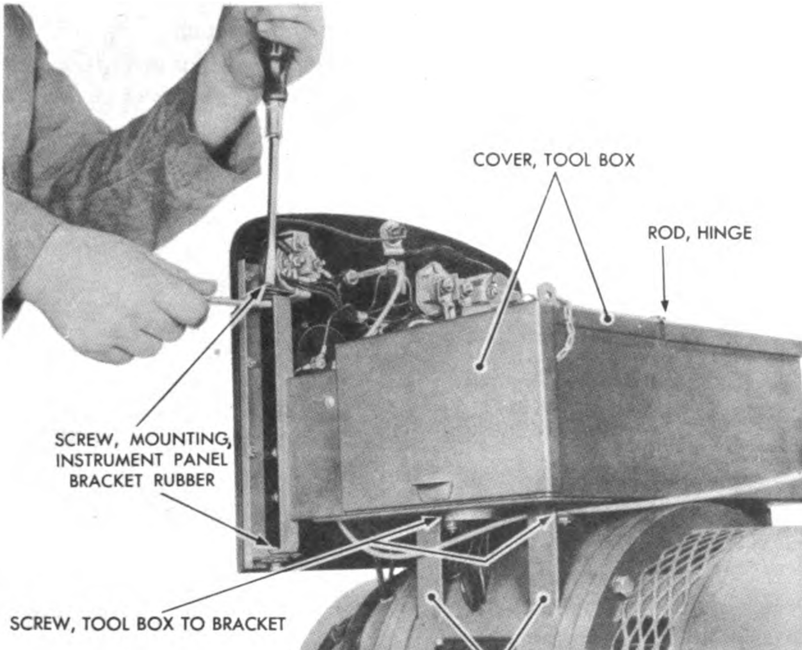


Figure 73 — Removing Tool Box

(2) Place resistor in position on reverse side of change-over panel, between binding posts "1" and "2" (fig. 71).

(3) Connect each of the 11 wires to rear of binding post bearing same mark as stamped on terminal of wire. Install lock washer and nut on each binding post except "3," to which no wire is connected (fig. 71).

(4) Install change-over bars on binding posts. If the unit is to be used on 60 cycles, put bars between posts "2" and "3," "RA" and "A," "RB" and "B," "RC" and "C." If unit is to be used on 50 cycles, put bars between binding posts "1" and "2," "1A" and "RA," "1B" and "RB," "1C" and "RC." Over bar on each post install lock washer and nut (½-in. open-end wrench) (fig. 72).

60. TOOL BOX.

a. Removal (fig. 73).

SCREWDRIVER — WRENCH, open-end, ½-in.
WRENCH, open-end, ⅜-in.

(1) Remove housing (par. 14).

(2) Remove change-over panel (par. 59).

(3) Remove switchboard bracket rubber mounting screws and safety nuts (screwdriver and 3/8-in. open-end wrench) (fig. 73).

(4) Remove tool box support bracket screws and safety nuts (screwdriver and 1/2-in. open-end wrench). Remove choke control clip from under right front screw nut.

(5) Lift tool box from tool box support bracket.

b. Disassembly.

HAMMER
PUNCH
PLIERS

Remove hinge rod from cover hinge (punch, hammer and pliers) (fig. 73). Lift covers from tool box.

c. Inspection and Repair.

CLOTH
DOLLY
HAMMER
SOLVENT, dry-cleaning
WELDING EQUIPMENT

(1) Clean tool box (SOLVENT, dry-cleaning) and dry with a clean cloth.

(2) Visually inspect box and covers to see if they are bent or broken. Straighten bent parts (hammer and dolly). Weld broken parts (welding equipment).

(3) Inspect cover hinge rod to see if it is worn or bent. Straighten rod if bent (hammer and dolly). Replace rod if worn.

d. Assembly.

HAMMER

Set covers in closed position on tool box. Drive hinge rod through the hinge (hammer) (fig. 73).

e. Installation.

SCREWDRIVER
WRENCH, open-end, 3/8-in.
WRENCH, open-end, 1/2-in.

(1) Place tool box in position on tool box support bracket (fig. 74).

(2) Install tool box support bracket screws and safety nuts (screwdriver and 1/2-in. open-end wrench) (fig. 73). Be sure to install choke control clip under right front screw nut (fig. 73).

(3) Install instrument panel bracket rubber mounting screws (screwdriver and 3/8-in. open-end wrench) (fig. 73).

(4) Install change-over panel (par. 59).

(5) Install housing (par. 19).

61. DUPLEX RECEPTACLE.

a. Removal (fig. 74).

SCREWDRIVER
WRENCH, open-end, 1/2-in.

CHANGE-OVER PANEL, TOOL BOX, AND RECEPTACLES

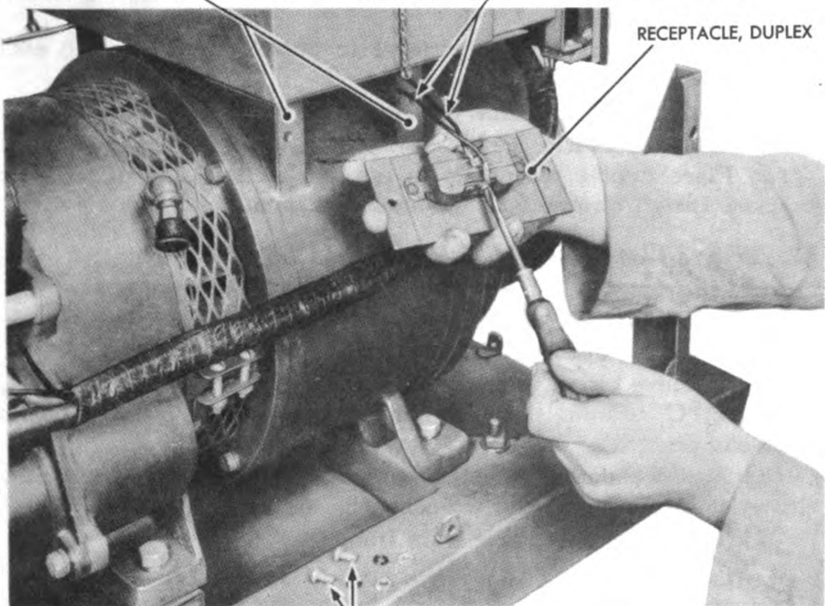


Figure 74 — Removing Duplex Receptacle

(1) REMOVE RECEPTACLE FROM BRACKET.

SCREWDRIVER | WRENCH, open-end, ½-in.

(a) Remove duplex receptacle-to-tool box bracket screws, nuts, and lock washers.

(2) DISCONNECT RECEPTACLE.

SCREWDRIVER

(a) Pull duplex receptacle away from tool box bracket, and disconnect circuit breaker to duplex receptacle wires from duplex receptacle.

b. Inspection and Repair.

BRUSH, wire (power driven) | COMPRESSED AIR
CLOTH, abrasive, aluminum-oxide

(1) Clean exterior of duplex receptacle by buffing it on a power driven wire brush. Clean dust from the assembly with compressed air. Clean terminals with CLOTH, abrasive, aluminum-oxide.

(2) Inspect Bakelite body of receptacle; replace if broken.

c. Installation.

SCREWDRIVER | WRENCH, open-end, ½-in.

(1) CONNECT RECEPTACLE.
SCREWDRIVER

(a) Connect wire (circuit breaker to duplex receptacle) to each of the terminals of duplex receptacle.

(2) INSTALL RECEPTACLE ON BRACKET.
SCREWDRIVER WRENCH, open-end, ½-in.

(a) Place duplex receptacle in position on left side of tool box bracket. Install screws, lock washers, and nuts (fig. 74).

62. THE 3-POLE OUTLET RECEPTACLE.

a. Removal.
SCREWDRIVER WRENCH, open-end, ½-in.
WRENCH, open-end, ⅜-in.

(1) Remove circuit breaker to outlet receptacle wires from "A," "B," and "C" terminals on left-hand side of circuit breaker (⅜-in. open-end wrench).

(2) Remove outlet receptacle-to-frame screws and nuts (screwdriver and ½-in. open-end wrench) (fig. 6).

(3) Lift outlet receptacle from frame.

b. Disassembly (fig. 75).
SCREWDRIVER

(1) Unscrew cover from body and remove split ring (screwdriver).

(2) Lift insulator, retainer, and wires from body.

(3) Remove gasket from receptacle cover.

c. Inspection and Repair.
SOLDERING EQUIPMENT

(1) Inspect all soldered connections and solder all broken connections (soldering equipment).

(2) Inspect condition of all gaskets and replace those broken or worn.

(3) Check all insulation, replacing broken and worn parts.

d. Assembly.
SCREWDRIVER

(1) Pass wires through receptacle body, and position retainer and insulator in body.

(2) Insert split ring in body to secure insulator and retainer in position (screwdriver).

(3) Assemble the cover gasket to receptacle cover, and screw cover onto body.

e. Installation.
SCREWDRIVER WRENCH, open-end, ½-in.
WRENCH, open-end, ⅜-in.

CHANGE-OVER PANEL, TOOL BOX, AND RECEPTACLES

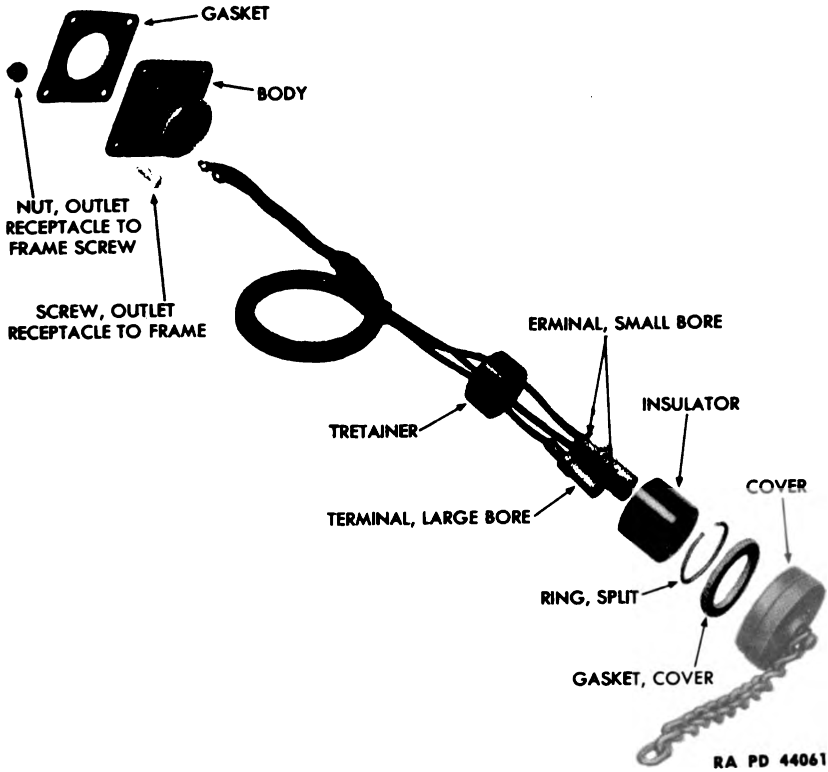


Figure 75 — 3-pole Outlet Receptacle Assembly — Exploded View

(1) Place receptacle in position, with gasket between frame and receptacle.

(2) Secure to frame with four screws and nuts (screwdriver and ½-in. open-end wrench).

(3) Attach "A," "B," and "C" wires to their proper terminals on back of circuit breaker (⅜-in. open-end wrench).

63. THE 19-POLE OUTLET RECEPTACLE (UNIT M6).

a. Removal.

SCREWDRIVER
WRENCH, open-end, ½-in.
WRENCH, open-end, ⅜-in.

(1) Remove wires from "A," "B," and "C" terminals on left-hand side of circuit breaker (⅜-in. open-end wrench).

(2) Remove outlet receptacle-to-frame screws and nuts (screwdriver and ½-in. open-end wrench) (fig. 7).

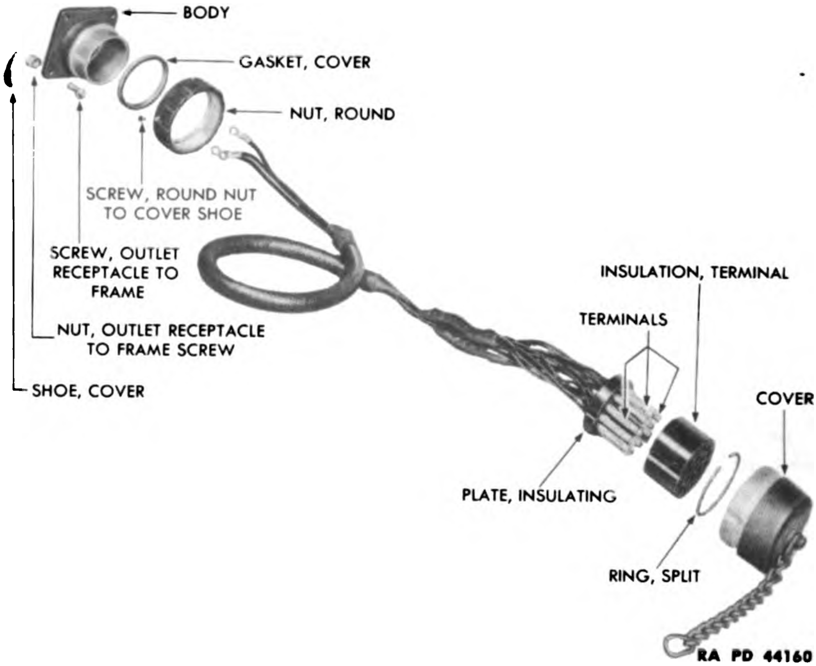


Figure 76 — 19-pole Outlet Receptacle Assembly — Exploded View

(3) Lift outlet receptacle from frame (fig. 7).

b. Disassembly (fig. 76).

SCREWDRIVER

(1) Screw round nut from cover. Lift cover from body.

(2) Remove split ring from body.

(3) Lift terminal insulation from body and slide body back off the wires.

(4) Remove cover shoe screws. Lift cover shoes from round nut, and round nut from body.

(5) Lift cover gasket from body.

c. Inspection and Repair.

COMPRESSED AIR SOLVENT, dry-cleaning
SOLDERING EQUIPMENT

(1) Clean all metal parts in SOLVENT, dry-cleaning, and dry with compressed air.

(2) Inspect all soldered connections; solder broken connections (soldering equipment).

(3) Inspect all gaskets and insulators. Replace broken or worn parts.

(4) Inspect all metal parts. Replace broken or bent parts.

d. **Assembly** (fig. 76).

SCREWDRIVER

(1) Push cover gasket on body.

(2) Place round nut on body, collar end first. Insert cover shoe under collar, and install round nut to cover shoe screws. Repeat operation to install remaining cover shoes and screws.

(3) Slide body on wires but not on insulating plate.

(4) Fit terminal insulation over terminals, up against insulating plate. Be sure groove in terminal insulation lines up with groove in insulating plate.

(5) Insert insulating plate and terminal insulation into body. NOTE: Groove will allow it to fit together in but one position.

(6) Insert split ring in end of body (fig. 76).

e. **Installation.**

SCREWDRIVER — WRENCH, open-end, ½-in.
WRENCH, open-end, ⅜-in.

(1) Place outlet receptacle in position on frame. Install screws (screwdriver and ½-in. open-end wrench) (fig. 7).

(2) Connect wires "A", "B", and "C" to terminals; "A", "B", and "C" on left side of circuit breaker (⅜-in. open-end wrench) (fig. 70).

Section IX

ENGINE (GENERAL)

64. DESCRIPTION.

a. The engine is a 4-cylinder Hercules, model ZXB, 4-cycle, L-head gasoline engine. It produces 11 horsepower.

b. Cylinder Block and Main Bearings. Constituting the main frame of the engine, the cylinder block and crankcase are cast integrally. The cylinders are water-jacketed the full length of the bore. Three main bearings support the crankshaft. These bearings consist of babbitt-lined shells for the top half of the bearing and babbitt-lined drop forged caps for the lower half. Two large alloy-steel cap screws secure the bearing caps to the cylinder block. Bearing adjustment is made by adding or removing shims.

c. Cylinder Head. Conventional in design, the cylinder head is a 1-piece casting. It is secured to the cylinder block with 13 cap screws and 2 stud nuts. It is designed so that the major part of the combustion chamber is over the valves. To ensure adequate cooling, the cylinder head is completely water-jacketed.

d. Connecting Rods and Pistons.

(1) Babbitt for connecting rod bearings is poured directly into the steel of the connecting rod and cap. Two alloy-steel connecting rod bolts secure the cap to the rod. The piston pin is clamped into the top of the rod by the connecting rod piston pin clamp screw. This device prevents the piston pin from working loose and scoring the cylinder walls.

(2) Cast-iron pistons are used. Bronze bearings are provided in the piston pin bosses. Each piston has two compression rings and one oil ring.

e. Exhaust and Intake Manifold. This engine is equipped with an exhaust and intake manifold cast in one piece.

f. Accessory Drive. An accessory drive assembly on left front corner of the engine is the means of driving the water pump, distributor, and battery charging generator.

ENGINE (GENERAL)

65. SPECIFICATIONS.

Make	Hercules
Model	ZXB
Rating:	
Bore	$2\frac{5}{8}$ in.
Stroke	3 in.
Horsepower (N.A.C.C.)	11
Piston displacement	64.9
Firing order	1-2-4-3
Lubrication	Forced feed to all connecting rods and main bearings
Cylinder Head:	
Type	Detachable
Valve arrangement	L-head
Exhaust valve diameter clearance	$\frac{7}{8}$ in.
Intake valve diameter clearance	$1\frac{1}{8}$ in.
Pistons:	
Material	Cast iron
Rings above pin	3
Rings below pin	0
Number of oil rings	1
Number of compression rings	2
Oil ring width	$\frac{3}{16}$ in.
Compression ring width	$\frac{1}{8}$ in.
Piston Pin:	
Diameter	$\frac{11}{16}$ in.
Bearing length	$1\frac{1}{2}$ in.
Bearing location	In piston
Number of bearings per piston	2
Crankshaft:	
Number of bearings	3
Bearing diameter	2 in.
Bearing length (front)	$1\frac{5}{16}$ in.
Bearing length (center)	$1\frac{3}{8}$ in.
Bearing length (rear)	$1\frac{3}{8}$ in.
Camshaft:	
Drive	Helical gear
Number of bearings	4
Diameter (front, center, and rear)	$1\frac{1}{4}$ in.
Length (front)	$1\frac{1}{8}$ in.
Length (center, Nos. 2 and 3)	$\frac{19}{32}$ in.
Length (rear)	$\frac{19}{32}$ in.
Location	Right-hand side of cylinder block
Connecting Rods:	
Bearing diameter	$1\frac{1}{2}$ in.

Bearing length .... 1 in.
Connecting rod length (center to center) .... 5 1/8 in.

Carburetor:

Size .... 5/8 in. SAE
Adjustment .... Idling speed only
Cooling .... Water pump

Generator:

Mounting .... Steel bracket on left side of cylinder block
Drive .... V-belt off accessory drive
Starting motor mounting ...... Standard SAE mount on bell housing
Spark plug size .... 14 mm.
Exhaust manifold bore .... 1 17/32 in.
Method of suspension .... 4 point

66. TROUBLE SHOOTING.

a. Engine Fails to Start.

Possible Cause	Possible Remedy
No gasoline in tank.	Fill gasoline tank.
Gasoline tank shut-off cock closed.	Open shut-off cock.
Water in gasoline tank, line, strainer, or carburetor.	Drain gasoline. Clean parts. Fill tank with gasoline.
Faulty carburetion.	Clean carburetor (pars. 138 and 139).
Gasoline line plugged.	Remove and clean gasoline line.
Dirt in fuel system.	Disassemble and clean components.
Throttle valve loose, stuck, or out of adjustment.	Free, connect, or adjust throttle valve.
Carburetor loose on manifold.	Tighten carburetor.
Manifold loose on cylinder block.	Tighten manifold.
Air cleaner improperly assembled.	Assemble air cleaner correctly (par. 136).
Distributor condenser short-circuited.	Replace distributor condenser (par. 99).
Broken or disconnected ignition wire.	Repair, replace, or connect ignition wire.
Ignition toggle switch off or broken.	Turn on or replace ignition toggle switch (par. 53).
Ignition coil to distributor high-tension cable disconnected.	Connect ignition coil to distributor high-tension cable.
Battery run down.	Recharge battery (par. 113).
Ignition coil defective.	Replace ignition coil (par. 97).
Distributor out of time.	Time distributor (par. 103).
Distributor point spring or rotor spring broken.	Replace distributor points or rotor (par. 99).

ENGINE (GENERAL)

Possible Cause	Possible Remedy
Sheared distributor drive gear pin.	Overhaul distributor and replace distributor drive gear pin (pars. 99 and 100).
Distributor points pitted.	Replace distributor points (par. 99).
Ignition cables, coil, and distributor wet.	Wash with SOLVENT, dry-cleaning, and wipe with dry cloth.
Valves fail to close (after storage of unit).	Clean rust or deposits from valve stems and valve guides (par. 116).

b. Popping, Spitting, and Spark Knock.

Carbon deposits.	Clean carbon from engine.
Hot spot in cylinder head due to carbon formation or clogged water jacket.	Clean carbon deposits from engine (par. 117). Clean water jacket (par. 117).
Valve sticking.	See subparagraph i below.
Improper valve timing.	Time valves (par. 129).
Improper distributor timing.	Time distributor (par. 103).
Improper carburetion.	Clean carburetor (pars. 138 and 139).
Improper spark plugs.	Replace spark plugs (par. 104).
Improper spark plug gaps.	Adjust spark plugs (par. 104).
Spark plugs dirty.	Clean and adjust spark plugs (par. 104).
Exhaust valve heads too thin, causing hot spots.	Replace exhaust valve (pars. 116 and 129).
Weak valve springs.	Replace valve springs (pars. 116 and 129).
Broken valve spring.	Replace valve spring (pars. 116 and 129).
Broken valve.	Replace valve (pars. 116 and 129).
Broken valve spring seat.	Replace valve spring seat (pars. 116 and 129).
Broken valve spring pin.	Replace valve spring pin (pars. 116 and 129).
Valves not properly seated.	Grind valves (par. 125) or reface valves and valve seats (pars. 124 and 125).
Crossed spark plug wires.	Put spark plug wires in proper firing order (par. 104).
Distributor out of time.	Time distributor to engine (par. 103).
Ignition cables, coil, and distributor wet.	Wash with SOLVENT, dry-cleaning, and wipe with dry cloth.

c. Engine Missing or Sluggish.

Possible Cause	Possible Remedy
Ignition cables disconnected.	Connect ignition cables.
Ignition cables short-circuited.	Repair or replace ignition cables.
Spark plugs fouled or broken.	Clean or replace spark plugs (par. 104).
Spark plugs out of adjustment.	Clean and adjust spark plugs (par. 104).
Distributor points burned or pitted.	Replace distributor points (par. 99).
Distributor out of time.	Time distributor (par. 103).
Weak ignition coil.	Replace ignition coil (par. 97).
Governor loose.	Tighten governor.
Generator not functioning and battery weak.	Repair generator and recharge battery (par. 85).
Ignition coil, distributor, and cables wet.	Wash with SOLVENT, dry-cleaning, and wipe with dry cloth.
Faulty compression.	See subparagraph f below.
Faulty carburetion.	Clean carburetor (pars. 138 and 139).
Air cleaner dirty.	Clean air cleaner (par. 136).
Overheating.	See cooling system trouble shooting (par. 70).

d. Excessive Bearing Wear.

Crankshaft journal scored.	Grind or replace crankshaft (par. 127).
Crankshaft journal out-of-round.	Grind or replace crankshaft (par. 127).
Crankshaft or cylinder block oil passages obstructed.	Clean oil passages (par. 117).
Bearings sprung.	Replace bearings.
Bearings loose.	Adjust bearings (par. 129).
Bearings tight.	Adjust bearings (par. 129).
Crankshaft misalined.	Straighten or replace crankshaft (par. 127).
Bearings misalined.	Aline bearings with shims (par. 129).
Lack of engine oil.	Maintain proper engine oil level.
Low oil pressure.	Adjust oil pressure regulator (par. 161). Fit bearings properly (par. 129).
Connecting rod bent.	Straighten or replace connecting rod (par. 126).
Improper oil.	Use correct oil (par. 164).

e. Burned Valves and Seats.

Possible Cause	Possible Remedy
Weak valve springs.	Replace valve springs (pars. 116 and 129).
Broken valve springs.	Replace valve springs (pars. 116 and 129).
Broken valve spring seat.	Replace valve spring seat (pars. 116 and 129).
Improper engine oil.	Change to correct engine oil.

f. Faulty Compression.

Worn valves.	Grind valves (par. 125).
Valve seats pitted or worn.	Reface valve seats (par. 124).
Piston rings stuck.	Clean carbon from ring and piston, or replace one or both (par. 126).
Piston ring worn or broken.	Replace piston ring (par. 126).
Loose spark plugs.	Tighten spark plugs.
Cylinder head loose.	Tighten cylinder head cap screws and stud nuts.
Cylinder head gasket damaged or defective.	Replace cylinder head gasket (par. 116).
Pistons worn.	Fit new pistons (par. 126).
Cylinders worn.	Rebore cylinders (par. 124).
Worn valve stems.	Replace valves (par. 116).
Valve guides worn.	Replace valve guides (par. 116).
Valve spring broken or weakened.	Replace valve spring (pars. 116 and 129).
Valve spring seat broken.	Replace valve spring seat (pars. 116 and 129).
Valve spring seat pin broken.	Replace valve spring seat pin (pars. 116 and 129).
Valve timing incorrect.	Time valves (par. 129).

g. Excessive Engine Oil Consumption.

Worn piston rings.	Replace piston rings (par. 126).
Broken piston rings.	Replace piston rings (par. 126).
Gear cover loose.	Tighten gear cover.
Oil pan loose.	Tighten oil pan.
Defective oil seal.	Replace oil seal (par. 116).
Accessory drive loose.	Tighten accessory drive.
Bell housing loose.	Tighten bell housing.
Torn gasket.	Replace gasket.
Poor grade engine oil.	Use good engine oil.
Cylinder walls worn.	Rebore cylinders (par. 124).
Cylinder walls out-of-round.	Rebore cylinders (par. 124).

Possible Cause	Possible Remedy
Cylinder walls tapered excessively.	Rebore cylinders (par. 124).
Cylinder main bearings loose.	Adjust or replace cylinder main bearings (par. 129).
Connecting rod bearings loose.	Adjust connecting rod bearings or replace connecting rods (par. 129).
Piston ring gaps too large.	Replace piston rings (par. 126).
Piston rings improperly seated.	Replace piston rings (par. 126).
Engine overheating.	See cooling system trouble shooting (par. 70).
Piston oil ring slots filled with carbon.	Clean or replace piston rings (pars. 117 and 126).
Excessive oil pressure.	Adjust oil pressure regulator (par. 161).
Too much engine oil in engine.	Maintain proper engine oil level.
High or low engine oil pressure.	See lubrication system trouble shooting (par. 158).

h. Excessive Cylinder and Piston Wear.

Improper engine oil.	Change to correct engine oil.
Lack of engine oil.	Maintain proper oil level in engine.
Dirty engine oil.	Change engine oil.
Overheating.	See cooling system trouble shooting (par. 70).
Improper piston installation and fitting.	Fit new pistons (par. 126).
Piston rings improperly fitted.	Fit new piston rings (par. 126).
Piston ring broken.	Replace piston ring (par. 126).
Piston ring stuck.	Clean piston and ring, or replace either or both (par. 126).
Air cleaner loose.	Tighten air cleaner.
Air cleaner dirty.	Clean air cleaner (par. 136).
Carburetor delivering too rich mixture.	Clean carburetor (pars. 138 and 139).
Broken valve spring seat pin. .	Replace valve spring seat pin (pars. 116 and 129).
Improper valve timing.	Time valves (par. 129).
Carbon deposits on valve seat and valve head.	Clean carbon from parts (par. 117).
Valves sticking.	See subparagraph i below.
Improper type of valve.	Use proper valve.
Valve head too thin, causing hot sections.	Replace valve (pars. 116 and 129).

ENGINE (GENERAL)

Possible Cause	Possible Remedy
Valve seats too narrow.	Reface valve seats (par. 124).
Carburetor mixture too lean.	Clean carburetor.
Overheating.	See cooling system trouble shooting (par. 70).
Low grade fuel.	Use specified fuel.

i. Valves Sticking.

Valve stems lack proper clearance in valve guides.	Ream valve guides to obtain proper clearance.
Weak valve springs.	Replace valve springs (pars. 116 and 129).
Broken valve springs.	Replace valve springs (pars. 116 and 129).
Broken valve spring seat.	Replace valve spring seat (pars. 116 and 129).
Broken valve spring seat pin.	Replace valve spring seat pin (pars. 116 and 129).
Valve stems scored.	Replace valves (par. 125).
Valve stems dirty.	Clean valves.
Gum deposits from inferior gasoline or engine oil.	Clean parts. Use specified gasoline and engine oil.

j. Overheating.

Cooling system ineffective.	See cooling system trouble shooting (par. 70).
Insufficient amount of engine oil.	Maintain proper level of engine oil.
Carburetor choke valve partly closed.	Adjust choke control (par. 154).
Valves improperly timed.	Time valves (par. 129).
Clogged exhaust system.	Clean manifold, exhaust pipe adapter, muffler, and exhaust pipe.
Carburetor out of adjustment.	Clean and adjust carburetor (pars. 138 and 139).

67. TUNE-UP.

a. Equipment.

BRUSH, wire	SCREWDRIVER
GAGE, compression	VOLTMETER
HOT WATER	WRENCH, open-end, $\frac{9}{16}$-in.
OIL, engine, SAE 10	WRENCH, open-end, $1\frac{1}{16}$-in.

b. Procedure. Importance of periodic engine tune-up cannot be overstressed. Efficient engine operation cannot be maintained if tune-ups are forgotten or poorly done. Complete engine tune-up, as out-

lined below, must be done after each 200 hours of engine operation. Under adverse climatic conditions, tune-ups must be performed oftener. To avoid hit-and-miss methods, perform the steps in the following order.

(1) TEST COMPRESSION.

GAGE, compression	OIL, engine, SAE 10

(a) Remove all four spark plugs (par. 104).

(b) Hold a compression gage tightly in a spark plug opening. Push the starter button. Observe the gage reading. Repeat the operation on the three remaining cylinders. If all four cylinders have within 5 pounds of the same compression, the compression is satisfactory. If one or more cylinders have low compression, determine the cause as follows:

1. If compression on two adjacent cylinders is low, a faulty head gasket permitting compression leakage between the two cylinders, is indicated.

2. Pour about one-eighth pint of OIL, engine, SAE 10, into each cylinder having low compression. Repeat the test. If compression remains unchanged, sticking or poorly seating valves are indicated. If compression improves, worn cylinders, pistons, and piston rings are indicated.

(c) Correct the cause of low or uneven compression before attempting to tune up engine.

(2) CLEAN AND TEST SPARK PLUGS.

(a) Before installing spark plugs removed in step (1) above, clean, adjust, and test them (par. 104). Replace defective spark plugs. Install spark plugs.

(3) INSPECT AND TEST BATTERY AND CABLES.

BRUSH, wire	WRENCH, open-end, 9/16-in.
HOT WATER	WRENCH, open-end, 11/16-in.
VOLTMETER	

(a) Connect the positive lead of a voltmeter to the starting motor terminal. Connect the negative lead to an oil line or other good ground. Press the starter switch for 15 seconds with the ignition switch off. If the engine cranks rapidly with the voltmeter reading 5 or more volts, a satisfactory starting circuit is indicated. If the engine cranks slowly, or if the voltmeter reads under 5 volts, perform the following steps:

1. Check condition of battery (par. 113). Recharge or replace if necessary.

2. Remove the battery ground cable (9/16-in. open-end wrench and 11/16-in. open-end wrench), the battery to starter switch cable, and the starter switch to starting motor cable. Clean cable terminals,

switch and motor terminals, and battery parts with hot water and a wire brush. Install the cables.

(4) DISTRIBUTOR.

(a) Inspect the distributor breaker points. Replace (par. 99) if pitted or burned.

(b) Time the distributor (par. 103).

(5) COIL AND CONDENSER.

(a) Test operation of ignition coil (par. 97).

(b) Test operation of distributor condenser (par. 100).

(6) AIR CLEANER.

Service the air cleaner (par. 136).

(7) CARBURETOR.

Remove, disassemble, and clean the carburetor (pars. 137 and 138). Assemble and install the carburetor (par. 141).

(8) VALVE TAPPETS.

Adjust valve tappets with the engine warmed up and running (par. 129). NOTE: Paragraph reference is to adjustment of valve tappets with engine cold. Procedure is similar here except that proper clearance is 0.006 inch.

(9) COOLING SYSTEM.

SCREWDRIVER

(a) Inspect for leakage. Repair if found.

(b) Tighten all hose connection clamp screws (screwdriver).

(c) Check fan belt tension (par. 79).

(d) Check thermostat.

Section X

COOLING SYSTEM

68. DESCRIPTION AND CONSTRUCTION.

a. General. The cooling system consists of a radiator, radiator cooling fan, water pump, water passages in the cylinder block and head, thermostat, and connections between these units. It has a capacity of 5 quarts. The function of the cooling system is to maintain the engine at an efficient operating temperature. To perform this function properly, the cooling system must be kept free of any foreign matter that might tend to clog the water passages. The water pump must be leakproof, and must keep the water circulating in the system. The water passages in the cylinder block and head must be kept free from rust and corrosion so that heat may be properly dissipated. The hose connections must be in good condition, and all connections must be kept tight so that they will not leak. The cylinder head bolts must be kept tight to eliminate the possibility of exhaust gases entering the cooling system. Water is drawn from the bottom of the radiator by the water pump, and is forced under pressure through the water passages in the cylinder block and head, and back into the top of the radiator. The thermostat, mounted in the cylinder head, assists in maintaining proper water temperature under operating conditions.

b. Water Pump. The water pump is of the centrifugal type, and is mounted on the front of the engine. It is gear-driven from the accessory drive gear train. A vane type impeller is pressed on, and pinned to, the water pump drive shaft. The water pump drive shaft is flattened at the end, and fits into an opening in the accessory drive gear which drives the pump. The water pump is sealed against leaks by the use of a composition water pump rotary seal. This seal

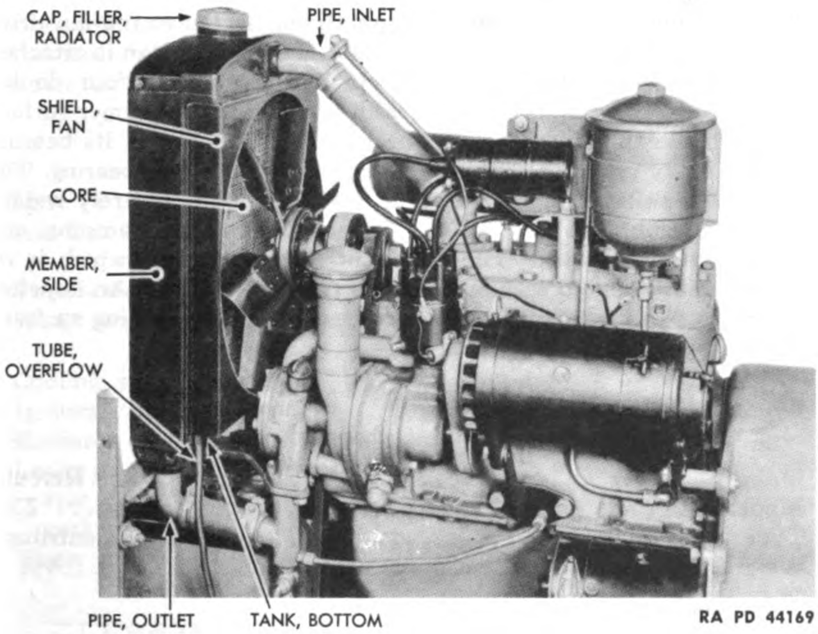


Figure 77 — Radiator Assembly and Connections

is retained in place by a water pump rotary seal spring, two water pump rotary seal washers, and a water pump shaft snap ring. The water pump shaft operates in a bronze bushing pressed into the water pump body. A large grease cup is provided for lubricating the pump shaft. The water bypass tube allows water circulation through the engine while the thermostat is closed.

c. **Radiator.** The radiator is of the copper fin and tube type, with brass upper and lower tanks. The tubes and fins are designed to give maximum heat radiation. Water from the cylinder head of the engine enters the upper tank of the radiator and passes through the radiator core (where it is cooled) to the lower tank. From the bottom tank, water is pumped back into the engine and cylinder head water jackets, to maintain proper engine temperatures. The upper water tank is provided with a radiator filler hole, radiator cap, overflow tube, and radiator water inlet pipe (fig. 77). The bottom tank is fitted with a radiator outlet pipe (fig. 77). The radiator core is made up of a series of brass tubes and fins, properly spaced and soldered to both the upper and lower tanks. The fan shield is a 1-piece sheet metal stamping, and is soldered or welded to the upper and lower tanks and side members. The two side members are soldered to the upper and lower tanks.

d. **Fan and Belt.** The radiator cooling fan is of the 6-blade steel pusher type, mounted on the shaft at the front of the engine. It is

driven by means of a rubber belt directly connected to the fan drive pulley on the front end of the crankshaft. The 6-blade fan is attached to the fan bearing by means of eight cap screws and four double nuts. The fan bearing is cast iron, with a highly finished inner surface in which the spindle operates. The spindle is steel, with its bearing surface finely ground to insure a free running fit in the bearing. The fan-driven pulley is a 2-piece sheet metal stamping, securely welded to the fan hub. The fan hub is a 1-piece sheet metal stamping, and acts as an oil reservoir. The hub is fitted with a plug, which is removed to fill the hub with OIL, engine (seasonal grade). An impeller, attached to the end of the spindle, forces oil into the bearing surfaces, assuring proper lubrication.

69. SPECIFICATIONS.

a. Water Pump.

Make .... Hercules
Model .... ZXB
Type .... Centrifugal
Weight .... 4½ lb

b. Radiator

Make .... McCord
Model J-41
Type .... Fin and tube
Weight .... 16 lb

c. Fan.

Make .... Switzer-Cummings
Type .... 6-blade pusher
Lubrication .... Oil plug in hub

d. Fan Belt.

Make .... Gates Vulco
Model 790
Type V
Outside circumference .... 32$\frac{7}{16}$ in.
Outside width .... $\frac{15}{16}$ in.
Inside width .... ¾ in.

e. Radiator Hose.

Material .... Reinforced rubber
Outside diameter .... 1¼ in.
Upper radiator hose length .... 7½ in.
Lower radiator hose length .... 3¾ in.
Water pump outlet hose length .... 1½ in.

f. Cooling System.

Capacity .... 5 quarts

COOLING SYSTEM

70. TROUBLE SHOOTING.

a. The following chart is provided as a guide to common troubles and their causes, and is a recommended procedure for inspection to locate the cause:

(1) OVERHEATING.

Possible Cause	Possible Remedy
Lack of water or antifreeze.	Fill cooling system.
Fan belt loose.	Adjust or replace fan belt (par. 79).
Thermostat sticking shut.	Replace thermostat (par. 130).
Water pump not operating.	Rebuild water pump (pars. 73, 74, 75, and 76).
Cooling system clogged.	Clean cooling system (par. 71).
Ignition timing incorrect.	Time engine (par. 103).
Radiator core passages clogged.	Clean radiator core (par. 71).
Leaks at connections, hoses, radiator core, or cylinder head gasket.	Tighten all connections, repair radiator core, and tighten or replace all hoses.
Water pump leaking.	Replace water pump seal (par. 73, 74, and 75).

(2) OVERCOOLING.

Thermostat not closing.	Replace thermostat (par. 130).

71. MAINTENANCE.

a. Equipment.

BUCKET, radiator filler	PLIERS
COMPRESSED AIR	SCREWDRIVER
GUN, reverse-flushing	SOLUTION, radiator cleaning
HOSE (2)	THERMOMETER
HYDROMETER	WRENCH, socket, $\frac{9}{16}$-in.
OIL, engine (seasonal grade)	

b. Procedure.

(1) GENERAL. Externally inspect cooling system components daily. After each 150 hours of operation, a detailed inspection of the components must be made.

(2) DAILY INSPECTION.

BUCKET, radiator filler	OIL, engine, SAE 30
HYDROMETER	SCREWDRIVER

(a) See that radiator is full of water. Add water if necessary (radiator filler bucket).

(b) When antifreeze is used, test strength with a hydrometer. Refer to chart (step (5) below). Add antifreeze if necessary.

(c) Inspect all hose connections for water leaks. Tighten clamps if necessary (screwdriver).

(d) Turn down grease cup on water pump. Fill if necessary.

(e) Remove oil plug from fan (screwdriver), and fill fan hub with approved OIL, engine (seasonal grade).

(f) Check fan belt tension. Adjust if necessary (par. 79).

(g) Visually inspect radiator for leaks. Repair if leaking.

(3) PERIODIC INSPECTION.

PLIERS	SOLUTION, radiator cleaning
SCREWDRIVER	THERMOMETER

(a) Remove thermostat. Test its operation by placing it in a pan of water. Heat the water and check the temperature at which the thermostat is fully opened (thermometer). Allow water to cool, and check temperature at which the thermostat is fully closed. The thermostat should be fully opened by the time the water temperature reaches 165 F, and fully closed by the time the water temperature reaches 140 F on cooling. Replace thermostat if found faulty.

(b) Remove all radiator hose connections (screwdriver). Visually inspect exterior and interior. Replace if cracked, rotted, or if inside has become spongy or jelly-like.

(c) Clean cooling system. Add an approved radiator cleaning solution, containing no acid or caustic, to radiator contents. Add enough water to fill the cooling system completely. Run engine 20 to 30 minutes with the radiator covered. Drain the cooling system; then close the drain cock (pliers). Fill system with water.

(d) If water drained from cooling system shows an unusual amount of scale and rust, the system must be reverse-flushed.

(4) REVERSE-FLUSH COOLING SYSTEM.

COMPRESSED AIR	HOSE (2)
GUN, reverse-flushing	SCREWDRIVER

(a) Radiator. Remove upper and lower radiator hose from radiator (screwdriver). Attach a hose (long enough to conduct water to a drain) to the upper radiator inlet pipe. Secure a length of hose to the lower radiator outlet pipe with a radiator hose clamp. Hold a reverse-flushing gun (connected to water and air hose) to the other end of this hose. Turn on the water. When the radiator is full, turn on a short blast of air. Repeat the operation until water discharged from the hose attached to the upper radiator inlet pipe, is clean.

(b) Engine Water Jacket. Remove the thermostat from the cylinder head, as cold water would cause it to close and as a result, build up a pressure in the system and cause damage. Remove the radiator outlet hose from the cylinder head water outlet, and the inlet hose from the water pump (screwdriver). Attach drain hose

to water pump inlet with a radiator hose clamp. Hold reverse-flushing gun to the cylinder head water outlet. Allow water jacket to fill with water. Turn on air in short blast. Repeat process until water hose attached to water pump discharges clean water.

(5) ANTIFREEZE IN COOLING SYSTEM.

BUCKET, radiator filler	SCREWDRIVER
PLIERS	WRENCH, socket, $^9/_{16}$-in.

(a) Inspect all cooling system components for leaks. If leaks are found, repair. Tighten all radiator hose connections (screwdriver). Tighten cylinder head cap screws and nuts ($^9/_{16}$-in. socket wrench). Clean and reverse-flush cooling system.

(b) Close the drain cock (pliers) and remove radiator cap.

(c) Determine the amount of antifreeze needed from chart below. Mix with water to make 5 quarts of solution.

ANTIFREEZE CHART

Anti-freeze	Water	COMPOUND antifreeze, (Ethylene Glycol type)	
Qt	Qt	°F	Gravity
0	5	32	1.000
½	4½	26	1.016
1	4	16	1.031
1½	3½	3	1.045
2	3	—11	1.058
2½	2½	—31	1.070

(d) Pour solution into radiator until it appears to be full. Start and run engine until thermostat opens. Pour remainder of solution into radiator.

(e) Run engine 20 to 30 minutes to insure thorough mixing of water and antifreeze.

72. WATER PUMP REMOVAL.

a. Equipment.

SCREWDRIVER	WRENCH, open-end, $^9/_{16}$-in.
WRENCH, open-end, ½-in.	

b. Procedure.

(1) Remove housing (par. 14).

(2) Remove battery (par. 113).

(3) Remove radiator (par. 78).

(4) Loosen hose clamp screws (screwdriver) on water pump discharge hose (fig. 78).

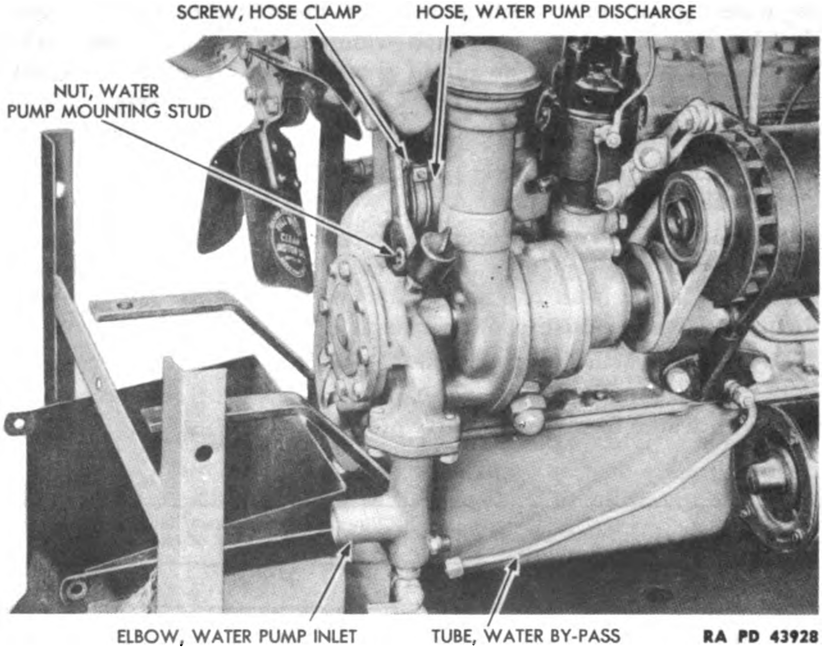


Figure 78 — Removing Water Pump

(5) Disconnect water bypass tube from water pump inlet elbow (½-in. open-end wrench) (fig. 78).

(6) Remove the two water pump mounting stud nuts and lock washers (9/16-in. open-end wrench) (fig. 78). To prevent breaking water pump discharge bracket, the bottom should be removed first and replaced last.

(7) Lift water pump and attached water pump inlet elbow, drain cock, and drain tube from engine.

73. WATER PUMP DISASSEMBLY (fig. 79).

a. Equipment.

DRIFT
DRIVER, bushing
HAMMER
PRESS, arbor
PUNCH, small
SCREWDRIVER (2)
VISE
WRENCH, open-end, 7/16-in.
WRENCH, open-end, ½-in.
WRENCH, open-end, 9/16-in.
WRENCH, open-end, 11/16-in.

b. Procedure.

(1) Remove water drain tube from drain cock (9/16-in. open-end wrench).

COOLING SYSTEM

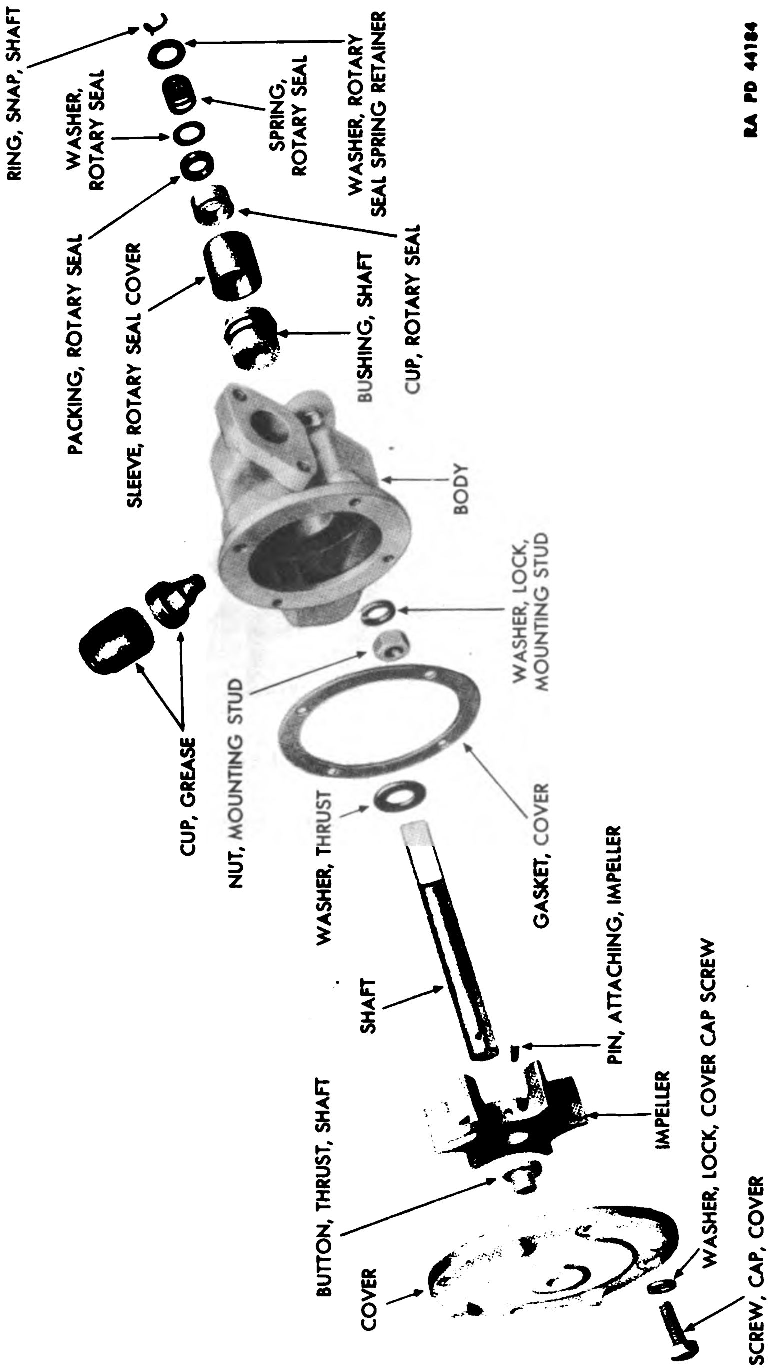


Figure 79 — Water Pump — Exploded View

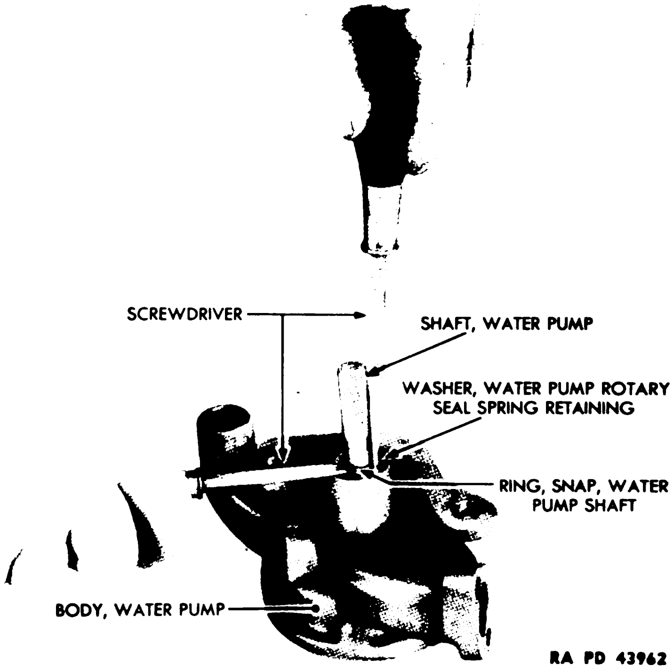


Figure 80 — Removing Water Pump Shaft Snap Ring

(2) Remove water drain cock from water inlet elbow ($^{11}/_{16}$-in. open-end wrench).

(3) Remove cap screws and lock washers which hold water pump inlet elbow to water pump body, and remove elbow and gasket (½-in. open-end wrench) (fig. 78).

(4) Remove grease cup from water pump body ($^{9}/_{16}$-in. open-end wrench).

(5) Remove four cap screws and lock washers which hold water pump cover to water pump body, and remove cover and gasket ($^{7}/_{16}$-in. open-end wrench) (fig. 79).

(6) Drive water pump shaft thrust button from water pump cover (hammer and small punch) (fig. 79).

(7) Press down water pump rotary seal spring retainer washer with one screwdriver, and remove water pump shaft snap ring with another screwdriver (fig. 80).

(8) Disassemble water pump rotary seal spring retainer washer, water pump rotary seal spring, water pump rotary seal washer, water

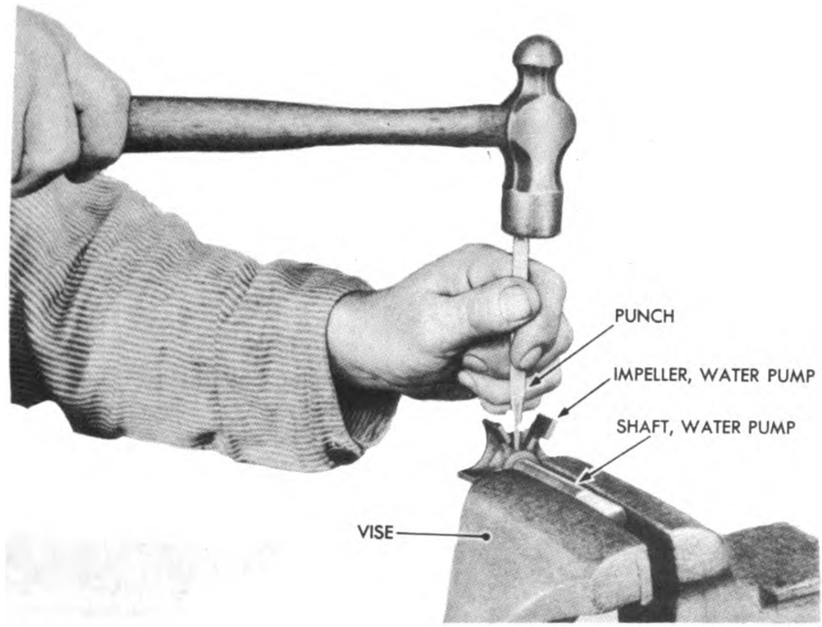


Figure 81 — Removing Pin from Water Pump Impeller and Shaft

pump rotary seal packing, and water pump rotary seal cup from the water pump shaft (two screwdrivers) (fig. 79).

(9) Lift water pump impeller, shaft, and thrust washer from water pump body (fig. 79).

(10) Holding water pump shaft securely in a vise, drive out pin attaching water pump impeller to water pump shaft (punch and hammer) (fig. 81).

(11) Support water pump impeller on the sides of an open vise, and drive water pump shaft from impeller (drift and hammer).

(12) Support water pump body in arbor press; press water pump shaft bushing from water pump body with a suitable bushing driver or pilot (fig. 82). CAUTION: Do not support water pump body on the attaching lugs, as they may break.

(13) Drive the water pump rotary seal cover sleeve from water pump shaft bushing (punch and hammer).

74. WATER PUMP INSPECTION.

a. Equipment.

COMPRESSED AIR
SOLVENT, dry-cleaning
WELDING EQUIPMENT

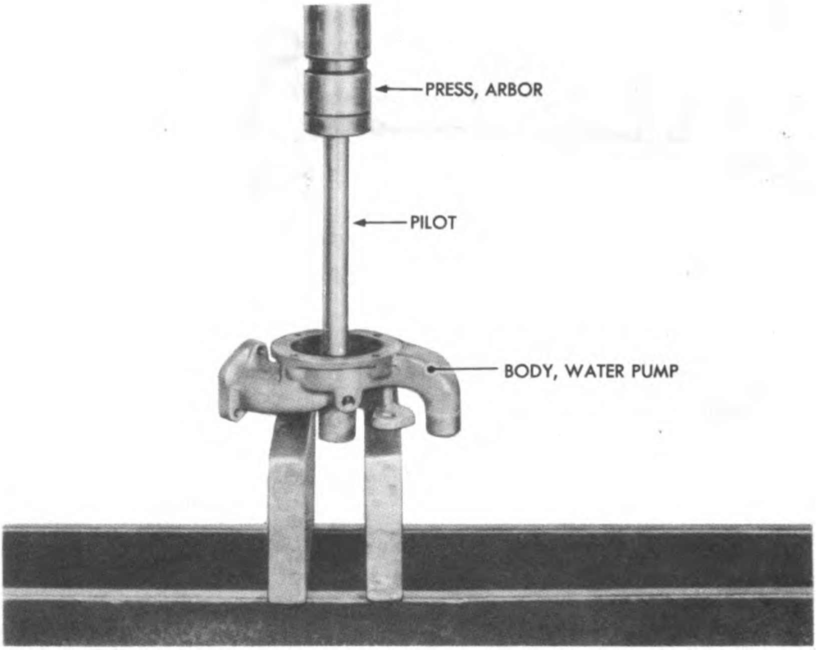


Figure 82 — Removing Water Pump Shaft Bushing from Body

b. Procedure.

(1) Clean all parts in SOLVENT, dry-cleaning, and dry with compressed air.

(2) Inspect water pump body and cover for cracks. Replace or weld, if broken (welding equipment).

(3) Inspect water pump shaft thrust button in cover, and replace if worn.

(4) Inspect fit of water pump shaft in impeller, and replace shaft or impeller, or both, if shaft is not a press fit in impeller.

(5) Inspect fit of water pump shaft in water pump shaft bushing, and replace bushing if worn enough to permit noticeable side play.

(6) Inspect water pump shaft for wear and damage. Replace if necessary.

75. WATER PUMP MAINTENANCE AND REPAIR.

a. Because of its construction, the water pump requires very little care, except that the grease cup must be kept filled with the specified lubricant, and turned down every day to insure proper lubrication of water pump shaft bushing.

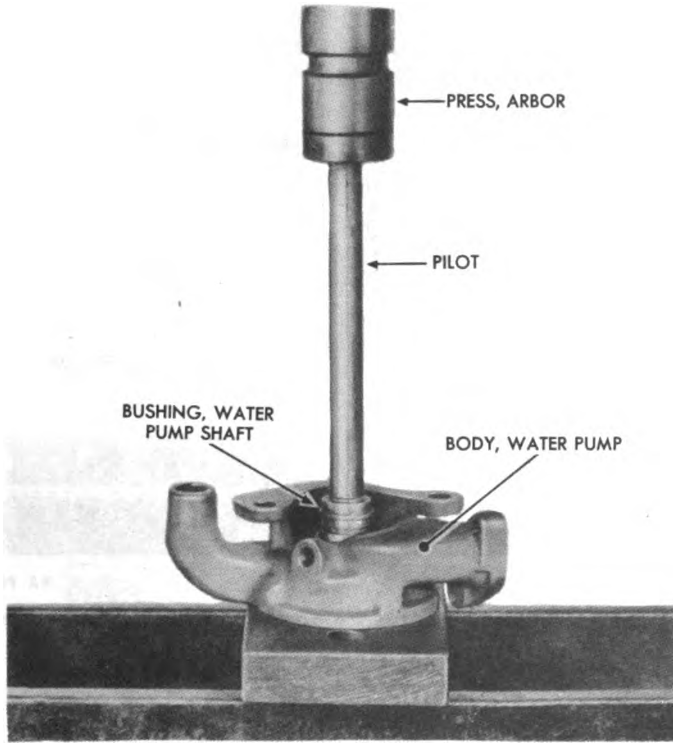


Figure 83 — Pressing Water Pump Shaft Bushing Into Body

b. In case of overhaul and repair, always use new gaskets, new water pump impeller pin, new water pump rotary seal cup, new water pump shaft thrust washer, new water pump shaft thrust button, and new water pump shaft snap ring. Replace other parts if worn or broken.

76. WATER PUMP ASSEMBLY.

a. Equipment.

HAMMER
PRESS, arbor
SCREWDRIVER
WRENCH, open-end, 7/16-in.
WRENCH, open-end, 1/2-in.
WRENCH, open-end, 9/16-in.
WRENCH, open-end, 11/16-in.

b. Procedure.

(1) Supporting water pump body in an arbor press, press water pump shaft bushing into body until shoulder of bushing is flush with outside of water pump body (fig. 83).

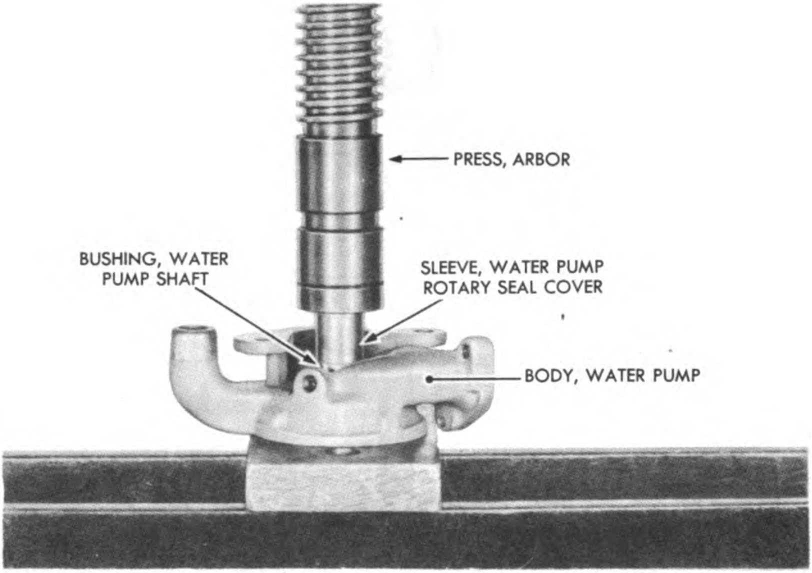


Figure 84 — Pressing Water Pump Rotary Seal Cover Sleeve Onto Water Pump Shaft Bushing

(2) Press water pump rotary seal cover sleeve over water pump shaft bushing, until sleeve is flush with flange on the water pump shaft bushing (arbor press) (fig. 84).

(3) Press shaft into impeller (fig. 85) making sure that pinhole in impeller lines up with pinhole in shaft. Drive pin in place (hammer).

(4) Assemble water pump shaft thrust washer over shaft, and assemble shaft and impeller to body with bushing (fig. 79).

(5) Assemble rotary seal cup, packing, washer, spring, and retaining washer over shaft and into rotary seal cover sleeve (fig. 79).

(6) Press down on rotary seal spring retainer washer to compress spring and assemble snap ring (screwdriver).

(7) Press a new thrust button into cover (arbor press) (fig. 79).

(8) Place cover on water pump body, and install cap screws and lock washers ($\frac{7}{16}$-in. open-end wrench).

(9) Assemble grease cup to body ($\frac{9}{16}$-in. open-end wrench) and fill with GREASE, water pump.

(10) Assemble water pump inlet elbow to body, using a new gasket (½-in. open-end wrench).

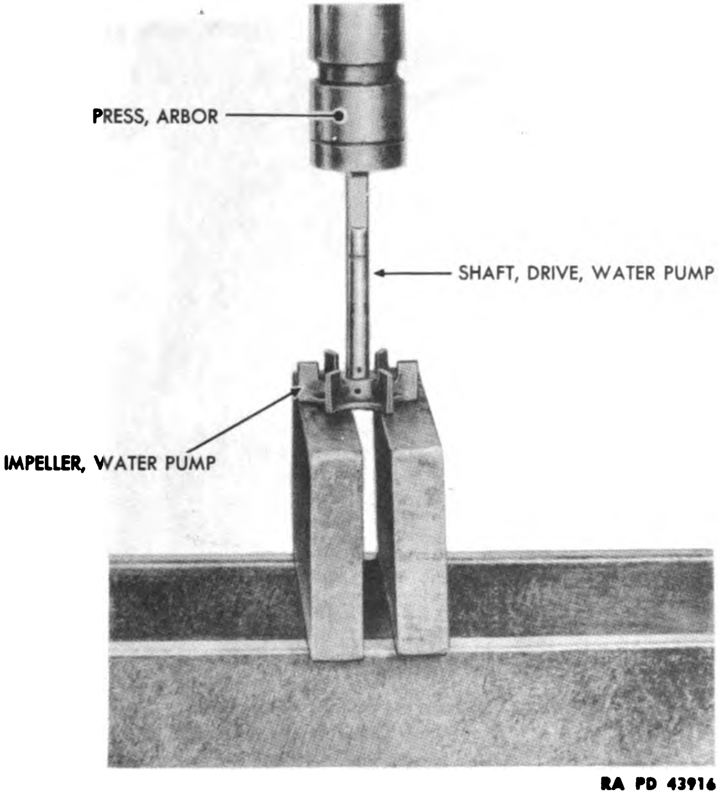


Figure 85 — Pressing Water Pump Shaft Into Impeller

(11) Assemble drain cock ($^{11}/_{16}$-in. open-end wrench) to water pump inlet elbow, and assemble drain pipe to drain cock ($^{9}/_{16}$-in. open-end wrench).

77. WATER PUMP INSTALLATION.

a. Equipment.

SCREWDRIVER
WRENCH, open-end, ½-in.
WRENCH, open-end, $^{9}/_{16}$-in.

b. Procedure.

(1) Place water pump assembly in position on engine (fig. 78).

(2) Install mounting stud nuts and lock washers ($^{9}/_{16}$-in. open-end wrench) (fig. 78).

(3) Connect bypass tube to water pump inlet elbow (½-in. open-end wrench) (fig. 78).

(4) Assemble discharge pipe hose to discharge side of pump, and tighten hose clamp screw (screwdriver) (fig. 78).

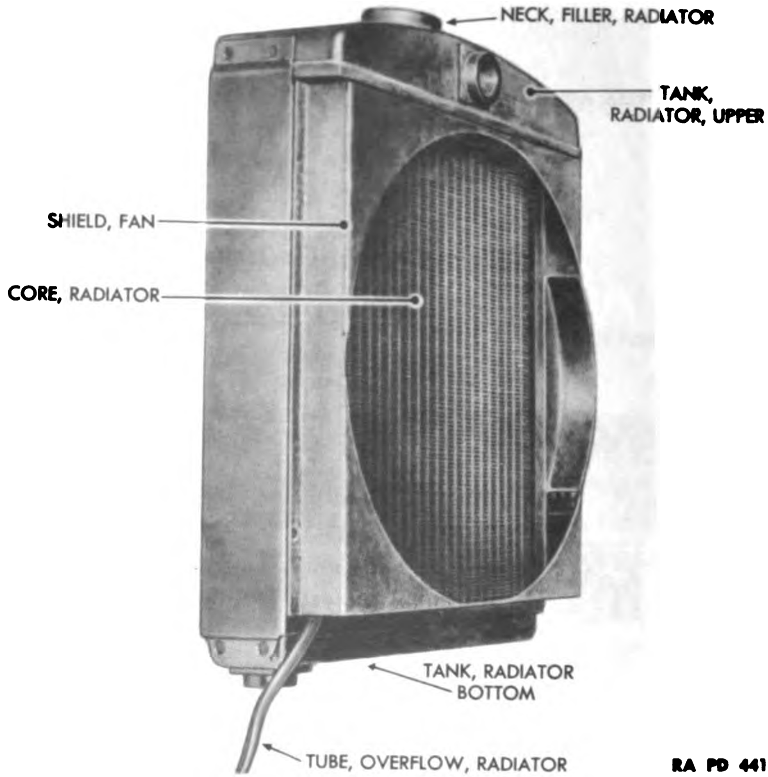


Figure 86 — Radiator Core and Tank Assembly

(5) Install radiator (par. 78).
(6) Install battery (par. 113).
(7) Install housing (par. 19).

78. RADIATOR.

a. Removal (fig. 87).

SCREWDRIVER WRENCH, socket, $\frac{9}{16}$-in.
WRENCH, open-end, ½-in. (2)

(1) Open drain cock and drain cooling system.

(2) Remove housing (par. 14).

(3) Remove battery (par. 113).

(4) Loosen upper and lower radiator hoses (screwdriver), and remove hoses from radiator pipes (fig. 2).

(5) Remove radiator tie rod (two ½-in. open-end wrenches). (fig. 2).

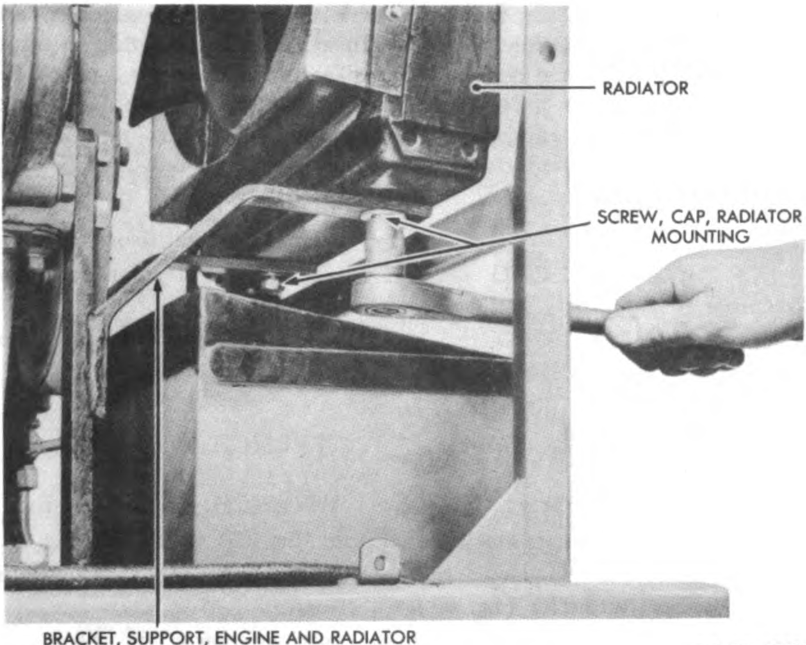


Figure 87 — Removing Radiator

(6) Remove two radiator mounting cap screws, plain washers, and lock washers ($\frac{9}{16}$-in. socket wrench).

(7) Lift radiator from engine and radiator support brackets.

b. Disassembly.

WRENCH, Stillson, 14-in.

(1) Remove inlet pipe from radiator (Stillson wrench) (fig. 77).

(2) Remove outlet pipe from radiator (Stillson wrench) (fig. 77).

(3) Remove radiator cap.

c. Inspection and Repair.

BLOCK, dolly
COMPRESSED AIR
HAMMER, sheet metal
PLUG, air inlet
PLUG, rubber or cork (4)
SOLDERING EQUIPMENT
WELDING EQUIPMENT

(1) See that radiator filler cap fits tightly on filler neck hole. If cap is not tight, bend lugs on cap, or in filler neck, until cap fits snugly.

(2) Visually inspect fan shield and side members for dents or breaks. Remove dents and weld breaks (dolly block, hammer, and welding equipment).

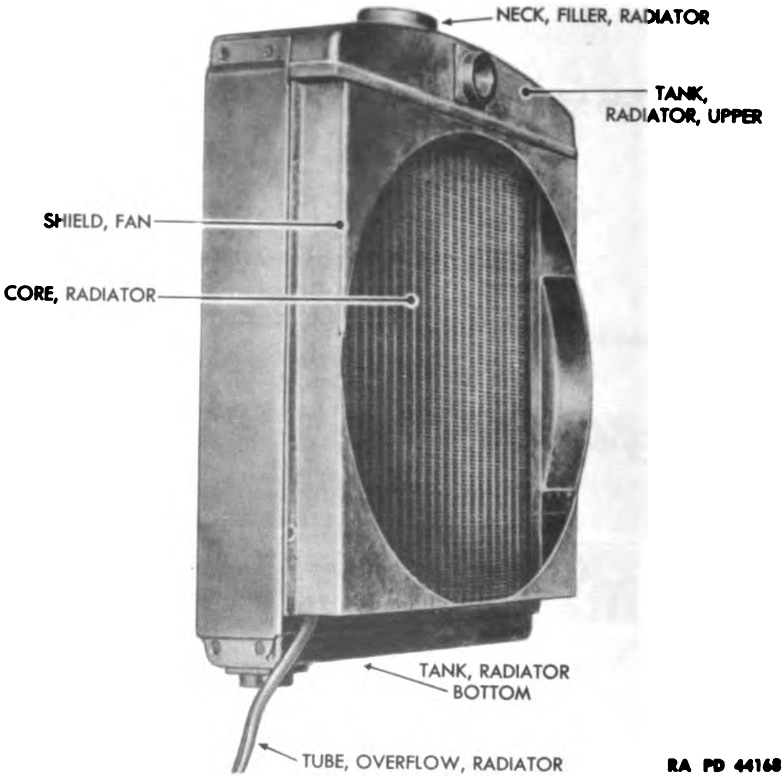


Figure 86 — Radiator Core and Tank Assembly

(5) Install radiator (par. 78).
(6) Install battery (par. 113).
(7) Install housing (par. 19).

78. RADIATOR.

a. Removal (fig. 87).

SCREWDRIVER
WRENCH, socket, 9/16-in.
WRENCH, open-end, ½-in. (2)

(1) Open drain cock and drain cooling system.
(2) Remove housing (par. 14).
(3) Remove battery (par. 113).
(4) Loosen upper and lower radiator hoses (screwdriver), and remove hoses from radiator pipes (fig. 2).
(5) Remove radiator tie rod (two ½-in. open-end wrenches). (fig. 2).

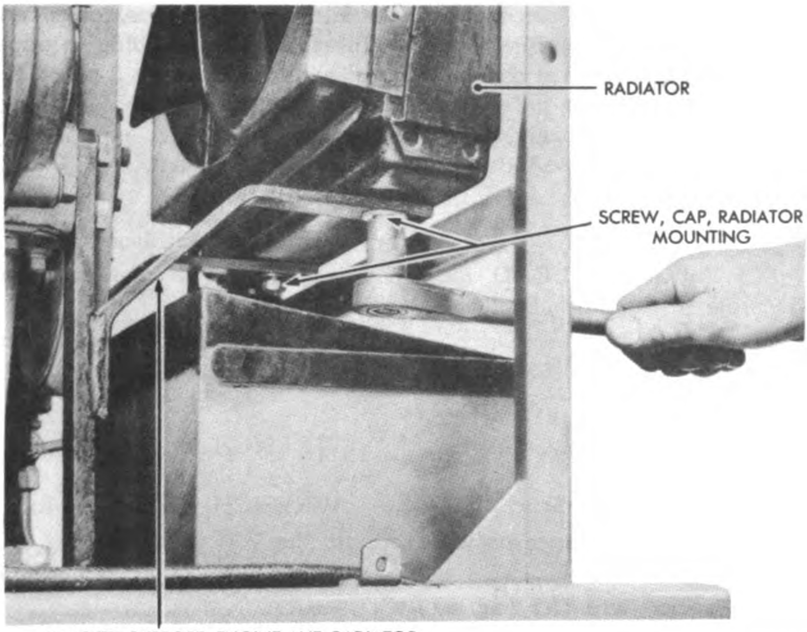


Figure 87 — Removing Radiator

(6) Remove two radiator mounting cap screws, plain washers, and lock washers (9/16-in. socket wrench).

(7) Lift radiator from engine and radiator support brackets.

b. Disassembly.

WRENCH, Stillson, 14-in.

(1) Remove inlet pipe from radiator (Stillson wrench) (fig. 77).

(2) Remove outlet pipe from radiator (Stillson wrench) (fig. 77).

(3) Remove radiator cap.

c. Inspection and Repair.

BLOCK, dolly
COMPRESSED AIR
HAMMER, sheet metal
PLUG, air inlet
PLUG, rubber or cork (4)
SOLDERING EQUIPMENT
WELDING EQUIPMENT

(1) See that radiator filler cap fits tightly on filler neck hole. If cap is not tight, bend lugs on cap, or in filler neck, until cap fits snugly.

(2) Visually inspect fan shield and side members for dents or breaks. Remove dents and weld breaks (dolly block, hammer, and welding equipment).

(3) Inspect radiator core for leaks. Plug overflow pipe, lower tank opening, and radiator filler opening. Insert an air inlet plug in upper tank opening. Immerse core in tank of water, and apply 3-pound air pressure in radiator core. Mark places where air bubbles out of core. Solder leaks, and repeat inspection (soldering equipment). CAUTION: Three pounds of air pressure is sufficient.

d. Assembly.

LEAD, red	WRENCH, Stillson

(1) Put a little LEAD, red, on threaded end of inlet pipe, and assemble to radiator (Stillson wrench) (fig. 77).

(2) Put a little LEAD, red, on threaded end of outlet pipe, and assemble to radiator (Stillson wrench) (fig. 77).

e. Installation.

BUCKET, radiator filler	WRENCH, open-end, ½-in. (2)
PLIERS	WRENCH, socket, 9⁄16-in.
SCREWDRIVER	

(1) Place radiator in position on unit (fig. 77).

(2) Install mounting cap screws, flat washers, and lock washers (9⁄16-in. socket wrench) (fig. 87).

(3) Install upper and lower hoses (screwdriver) (fig. 2).

(4) Install tie rod (two ½-in. open-end wrenches) (fig. 2).

(5) Install battery (par. 113).

(6) Install canopy (par. 19).

(7) Close radiator drain cock (pliers).

(8) Fill radiator (capacity of cooling system is 5 quarts) (radiator filler bucket).

79. FAN.

a. Removal.

WRENCH, open-end, 9⁄16-in.	WRENCH, open-end, 15⁄16-in.

(1) Remove muffler (par. 115).

(2) Loosen fan clamp nut (15⁄16-in. open-end wrench) (fig. 88).

(3) Remove fan bracket mounting cap screws and lock washers (9⁄16-in. open-end wrench) (fig. 88).

(4) Remove fan belt from pulley (fig. 88).

(5) Lift assembly and fan belt from unit.

b. Disassembly.

PLIERS	WRENCH, open-end, ⅜-in.
SCREWDRIVER	WRENCH, open-end, 15⁄16-in.

(1) Remove oil filler plug, and drain oil from fan hub (screwdriver) (fig. 89).

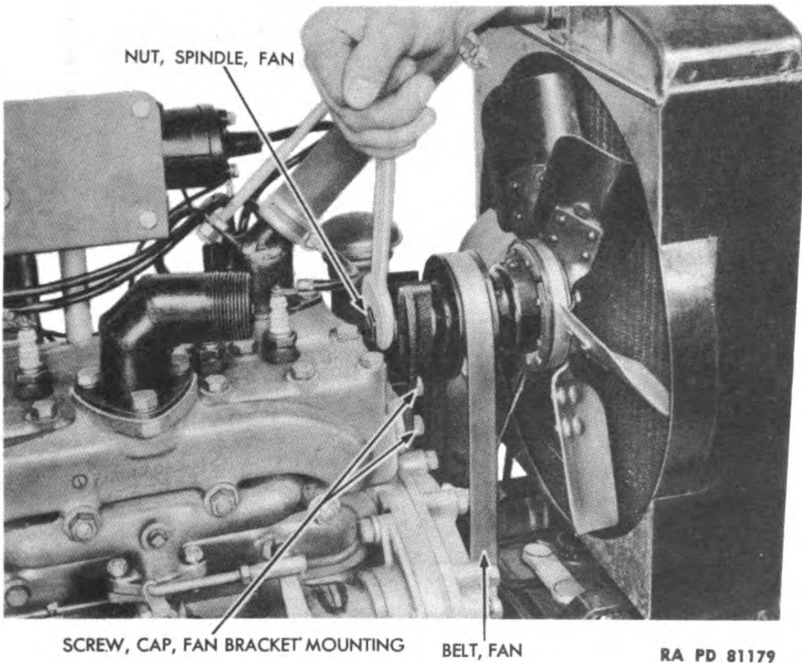


Figure 88 — Removing Fan

(2) Remove nut and flat washer from end of fan spindle, and remove fan mounting bracket ($^{15}/_{16}$-in. open-end wrench) (fig. 89).

(3) Remove eight cap screws, and lock washers, and four double-tapped nuts which hold fan blade to hub and fan spindle bearing ($^{3}/_{8}$-in. open-end wrench) (fig. 89).

(4) Lift fan blade spacer and gasket from hub (fig. 89).

(5) Remove cotter pin and clamp washer from spindle (pliers) (fig. 89).

(6) Remove hub from spindle and bearing (fig. 89).

(7) Remove spindle and gasket from bearing (fig. 89).

c. Inspection.

(1) Check fit of spindle in bearing.

(2) Check hub for tightness of pulley flanges.

(3) Check fan blades for loose rivets and cracks.

d. Maintenance and Repair.

(1) Keep fan hub filled at all times with OIL, engine (seasonal grade).

(2) Tighten all loose rivets, and straighten fan blades.

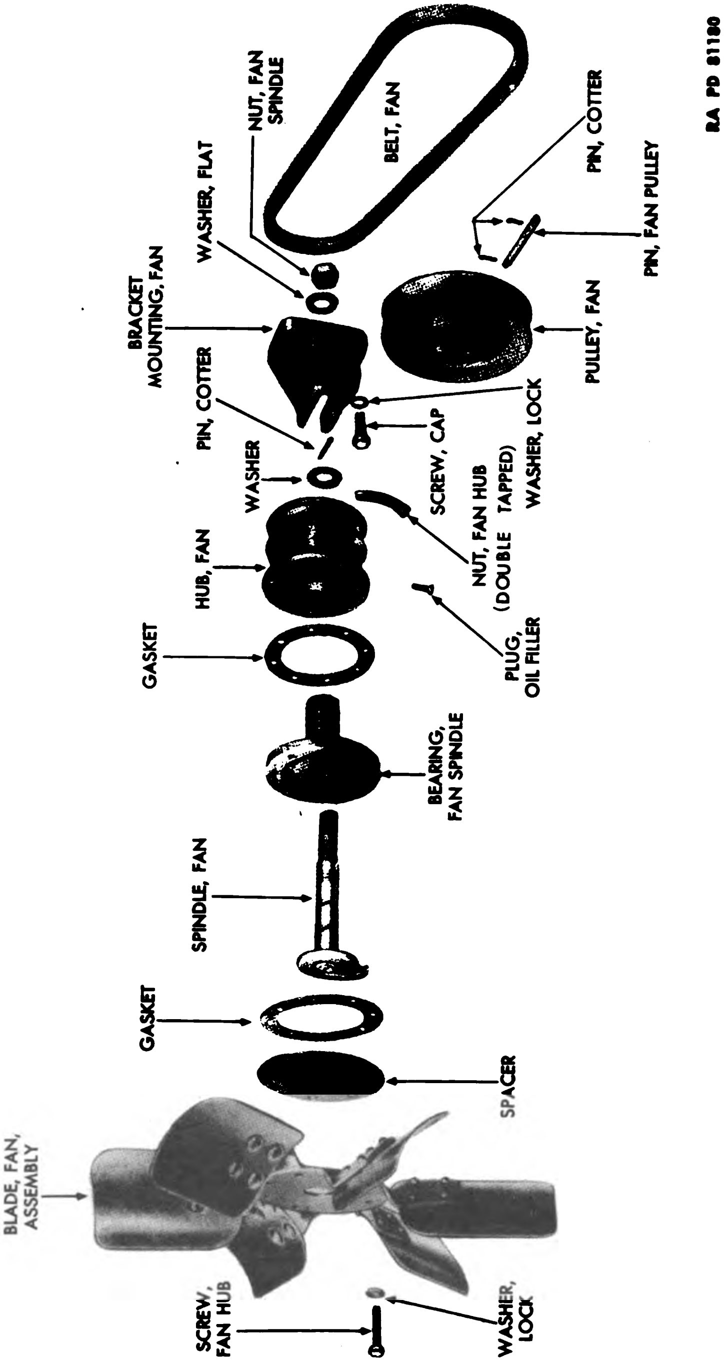


Figure 89 — Fan Assembly — Exploded View

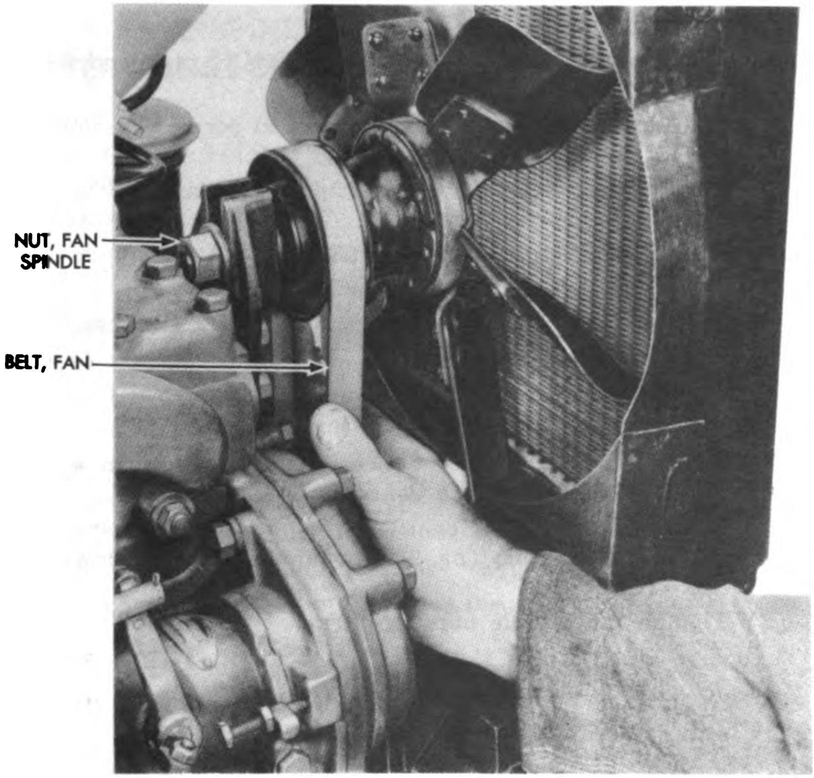


Figure 90 — Adjusting Fan Belt Tension

(3) Check spindle bearing clearance, and, if loose, replace worn parts.

e. Assembly.

PLIERS
WRENCH, open-end, 15/16-in.
WRENCH, open-end, 3/8-in.

(1) Assemble fan spindle to fan spindle bearing (fig. 89).

(2) Assemble hub gasket to fan spindle bearing (fig. 89).

(3) Assemble hub to bearing and spindle (fig. 89).

(4) Assemble clamp washer and cotter pin to spindle (pliers) (fig. 89).

(5) Assemble gasket and spacer to hub (fig. 89).

(6) Place fan blade in position, and assemble to hub and bearing with eight cap screws and lock washers and four double-tapped nuts (3/8-in. open-end wrench) (fig. 89).

(7) Assemble fan assembly to bracket with flat washer and fan spindle nut (15/16-in. open-end wrench) (fig. 89).

f. Installation.

OIL, engine, SAE 20 WRENCH, open-end, $\frac{9}{16}$-in.
SCREWDRIVER

(1) Place assembled fan and fan bracket in position on front end of cylinder block (fig. 88).

(2) Install fan bracket mounting cap screws and lock washers ($\frac{9}{16}$-in. open-end wrench) (fig. 88).

(3) Slip fan belt over pulley (fig. 88).

(4) Adjust fan belt tension (subpar. g below).

(5) Fill hub with OIL, engine (seasonal grade), and install filler plug (screwdriver).

g. Adjustment of Fan Belt Tension.

WRENCH, open-end, $\frac{15}{16}$-in.

(1) Grasp fan belt midway between pulleys. It must be loose enough to allow about a 1-inch deflection (fig. 90).

(2) If belt is too loose or too tight, loosen fan spindle nut ($\frac{15}{16}$-in. open-end wrench) (fig. 90) and push fan up or down until tension is correct.

(3) Tighten fan spindle nut (fig. 90).

Section XI

ENGINE ELECTRICAL SYSTEM: BATTERY CHARGING GENERATOR AND REGULATOR

Paragraph

80. DESCRIPTION.

a. Generator Circuit.

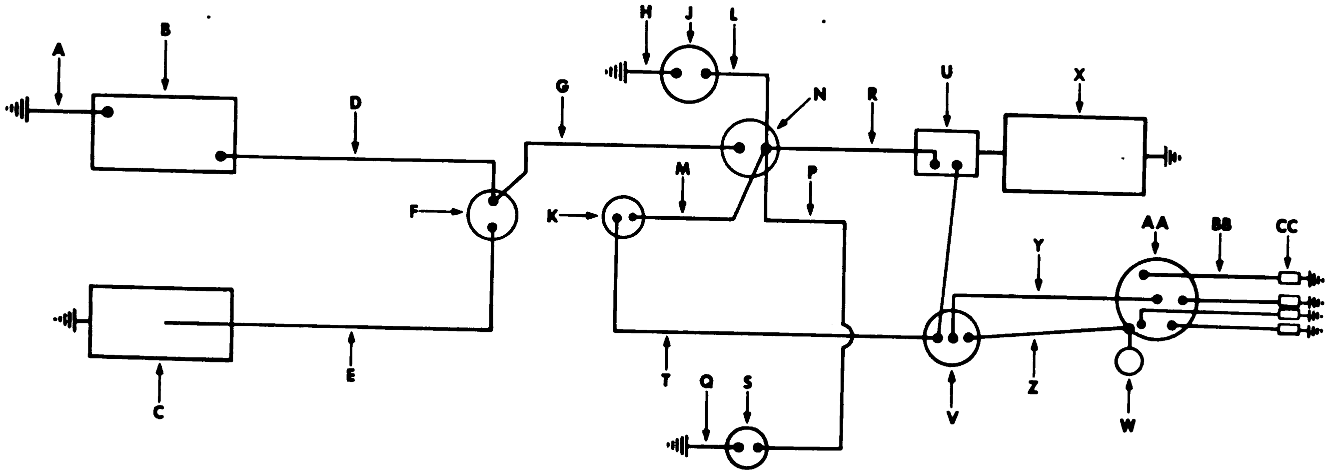
(1) The battery charging generator circuit consists of a generator, regulator, ammeter, battery, and connecting wires (fig. 92).

(2) Its function is to convert a small amount of mechanical energy from the engine into electrical energy, and store it for future use. This electrical energy, produced by the generator, is carried from the generator through the wiring to the storage battery. In actual operation some of the energy may be used directly from the generator.

b. Generator.

(1) The generator is a device for changing mechanical energy into electrical energy. It consists of four main subassemblies which are the frame and field, the armature, the commutator end plate, and the drive end head.

(2) The frame and field consists of the iron shell which supports the units and also forms part of the magnetic circuit, and the field coils which supply the magnetic field. The field coils are mounted on pole pieces which hold the coils in place, and also distribute the flux so that it flows evenly through the armature core and back through the frame. The armature is composed of the shaft, laminated iron core, the commutator, and the armature coils. The coils are wound in slots in the armature core, and the ends of the coils are clinched and soldered to the commutator bars. The commutator is composed



A—STRAP, GROUND, BATTERY
B—BATTERY
C—MOTOR, STARTING
D—CABLE, BATTERY TO STARTING SWITCH
E—CABLE, STARTING SWITCH TO STARTING MOTOR
F—SWITCH, STARTING
G—WIRE, STARTING SWITCH TO AMMETER
H—WIRE, INSTRUMENT PANEL LAMP TO OIL PRESSURE GAGE (GROUND)
J—LAMP, INSTRUMENT PANEL
K—SWITCH, IGNITION
L—WIRE, AMMETER TO INSTRUMENT PANEL
M—WIRE, AMMETER TO IGNITION SWITCH
N—AMMETER
P—WIRE, AMMETER TO TROUBLE LIGHT SOCKET
Q—WIRE, TROUBLE LIGHT SOCKET TO OIL PRESSURE GAGE (GROUND)
R—WIRE, GENERATOR REGULATOR TO AMMETER
S—SOCKET, TROUBLE LIGHT
T—WIRE, IGNITION SWITCH TO IGNITION COIL
U—REGULATOR, GENERATOR
V—COIL, IGNITION
W—CONDENSOR, IGNITION COIL
X—GENERATOR, BATTERY CHARGING
Y—CABLE, IGNITION COIL TO DISTRIBUTOR (SECONDARY)
Z—WIRE, IGNITION COIL TO DISTRIBUTOR (PRIMARY)
AA—DISTRIBUTOR, IGNITION
BB—CABLE, SPARK PLUG
CC—PLUG, SPARK

RA PD 44104

Figure 91 — Engine Wiring Diagram

ENGINE ELECTRICAL SYSTEM:
BATTERY CHARGING GENERATOR AND REGULATOR

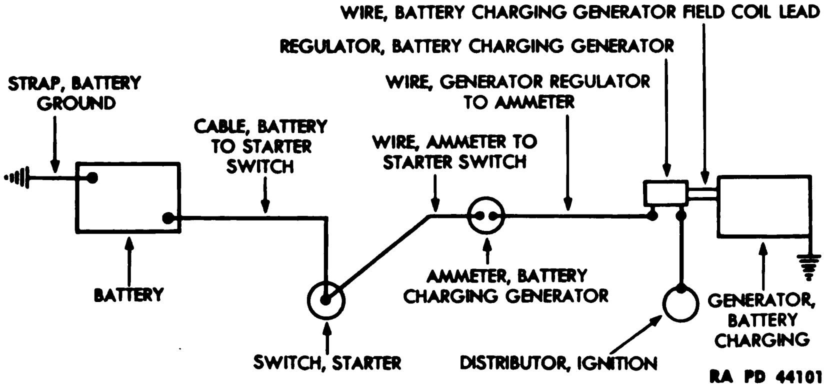


Figure 92 — Diagram of Battery Charging Generator Circuit

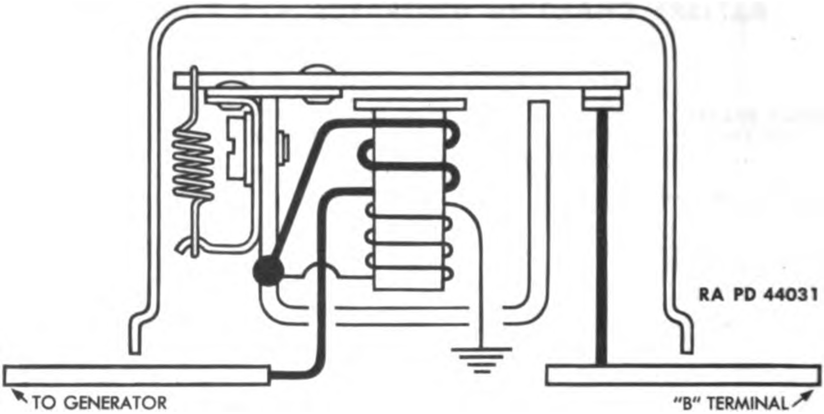
of copper wedges insulated from each other and from the shaft. The drive end head provides the support for the ball bearing and also supplies the mounting flange. The commutator end plate also supports a ball bearing and provides the support for the brush plates and arms. The brushes are mounted in these plates and are held against the commutator by the brush springs and arms. One of the brushes is grounded, and the other is connected to the armature terminal on the frame.

(3) To produce electrical energy, it is necessary to turn the armature. This causes the windings of the armature to cut the magnetic flux produced by the field coils. This cutting of a magnetic field by an electrical conductor produces a voltage in the armature conductors. The commutator and brushes are arranged so that the generated voltage is carried from the revolving armature to the armature terminal outside the generator. A small fraction of the current produced by the generator is bypassed through the field coils to produce the magnetic field. The output of the generator is determined by the strength of the field, and by the speed of the armature in cutting through the field. Since the speed of the generator cannot be regulated, the control of the generator output is accomplished by changing the field current. This is done by the action of the generator regulator.

(4) The generator windings are cooled by the action of a centrifugal fan mounted on the commutator end of the armature shaft. This fan draws air into the generator through the openings on the under side of the frame. The air passes over the armature and field windings, and through the holes in the commutator end plate, where it is expelled by the fan.

c. Generator Regulator.

(1) The generator regulator is a combination circuit breaker and



RA PD 44031

Figure 93 — Circuit Breaker Wiring Diagram

voltage regulator. The circuit breaker automatically opens and closes the circuit between generator and storage battery.

(2) The circuit breaker consists of an electromagnet and a set of contacts. The electromagnet has two windings; in one, the shunt coil is connected across the generator; in the other, the shunt coil is connected in series with the generator output (fig. 93).

(3) When the generator is charging the battery, the current is flowing through the shunt coil in one direction, and through the series coil in the opposite direction.

(4) The circuit breaker contacts consist of one movable contact mounted on an armature operated by the electromagnet and a stationary contact. These contacts are held open by an armature spring (fig. 94).

(5) When the generator is not running, the contacts are open. When the generator is started, the voltage builds up at the generator terminal and in the shunt coil. As soon as the voltage reaches the value for which the circuit breaker is calibrated, there is sufficient magnetism created by the shunt coil to pull down the armature. Close the contacts, and automatically connect the generator to the battery.

(6) With the contacts closed, the current in the series coil is flowing from the generator to the battery, or in the same direction as the current in the shunt coil, so that the pull on the armature is increased by the magnetism of the series coil.

(7) When the engine is stopping and the generator loses speed, the voltage falls. As soon as the generator voltage drops below the battery terminal voltage, the current flows from the battery to the generator, reversing the direction of the current in the series coil.

ENGINE ELECTRICAL SYSTEM: BATTERY CHARGING GENERATOR AND REGULATOR

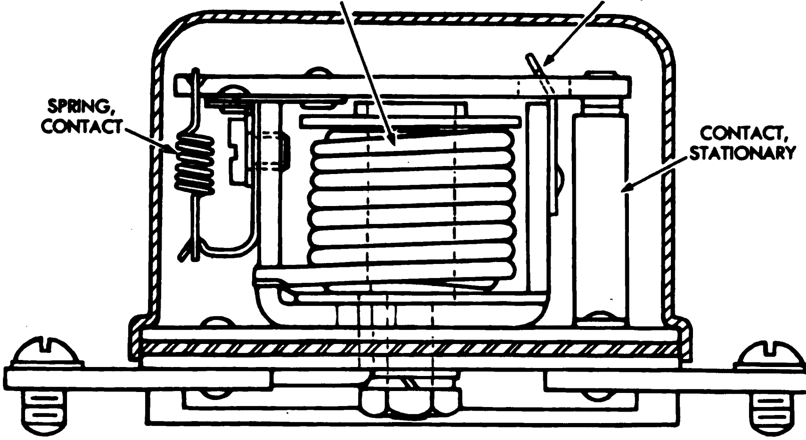


Figure 94 — Circuit Breaker — Cross Section View

Then the magnetism created by the series coil is opposed to the magnetism created by the shunt coil. This reduces the magnetic pull on the armature, and the spring opens the contacts, disconnecting the generator from the battery (fig. 94).

(8) The voltage regulator operates on the principle of inserting a resistance in the generator field circuit when the generator voltage reaches a predetermined value. To meet battery characteristic changes resulting from temperature changes, a magnetic bypass is used (fig. 95).

(9) The magnetic bypass type of compensation operates by varying the amount of magnetic pull exerted on the armature at any given voltage, according to the temperature.

(10) The magnetic bypass is a small piece of nickel-iron across the top of the magnetic core. The magnetic conductivity of this bypass gradually increases as its temperature is reduced. Thus, at low temperatures, much of the magnetic pull of the core, which would normally affect the cutting-in of the field resistance, flows through this bypass instead of the regulator armature. The result is that a higher generator voltage is required to open the contacts and cut in the field resistance.

(11) At high temperatures the magnetic conductivity of the bypass is reduced, allowing the magnetic pull of the core to have full effect on the regulator armature, and to cut in the field resistance at a lower generator voltage.

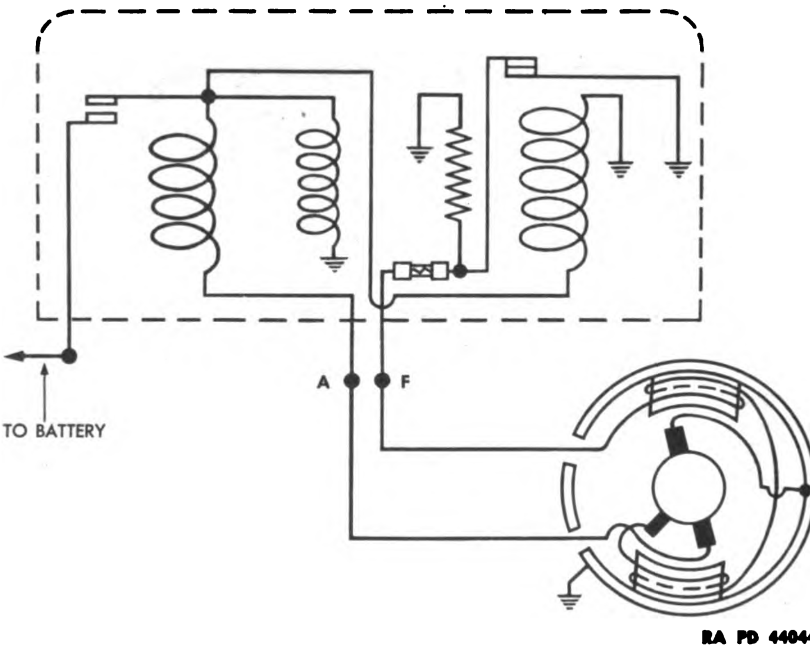


Figure 95 — Generator Regulator Wiring Diagram

81. SPECIFICATIONS.

a. Generator.

Make	Delco-Remy
Model	6-volt
Rotation	Clockwise, viewed from drive end
Number of brushes	3
Number of poles	4

b. Circuit Breaker.

Make	Auto-Lite
Model	TC-4323-C
Circuit breaker armature air gap	0.010 to 0.030 in.
Contact point gap	0.015 to 0.045 in.
Voltage regulator armature air gap	0.044 to 0.046 in.
Voltage regulator contact point gap	0.005 in. minimum

82. TROUBLE SHOOTING.

a. Low or No Generator Output.

Possible Cause	Possible Remedy
Dry battery.	Refill battery cells.
Poor battery condition.	Replace battery (par. 113).
Loose connections.	Tighten connections (par. 113).

ENGINE ELECTRICAL SYSTEM: BATTERY CHARGING GENERATOR AND REGULATOR

Possible Cause	Possible Remedy
Dirty connections.	Clean and tighten connections (par. 113).
Burned contacts on regulator.	Clean or replace contacts (par. 90).

b. High Discharge on Ammeter.

Regulator circuit breaker closed.	Repair or adjust circuit breaker (par. 90).

c. Noise at Engine Idle Speed.

Broken bearing.	Replace bearing (pars. 84 and 86).
Loose pulley.	Tighten pulley (par. 86).
Loose pole piece.	Tighten pole piece (par. 86).
Commutator damaged.	Repair commutator or replace armature (pars. 84 and 85).

d. Low Charging Rate.

Dirty commutator.	Clean commutator (par. 85).
Fan belt loose.	Adjust fan belt (par. 79).
Voltage regulator improperly adjusted.	Adjust regulator (par. 92).
High resistance in charging circuit.	Clean and tighten battery terminals and check circuit for loose connections (par. 113).
Third brush improperly adjusted.	Adjust third brush (par. 86).

e. High Charging Rate.

Third brush improperly adjusted.	Adjust third brush (par. 86).

83. GENERATOR REMOVAL.

a. Equipment.

SCREWDRIVER
WRENCH, open-end, ½-in.
WRENCH, open-end, ⅝-in.

b. Procedure.

(1) Disconnect ignition coil wire from battery charging generator regulator (screwdriver) (fig. 110).

(2) Disconnect ammeter wire from battery charging generator regulator (screwdriver) (fig. 110).

(3) Remove drive belt tension adjusting cap screw, lock washer, plain washer, and spacer (½-in. open-end wrench) (fig. 96).

(4) Remove generator mounting cap screw lock nut (⅝-inch open-end wrench) (fig. 96).

(5) Loosen the two mounting cap screws (½-in. open-end wrench) (fig. 96).

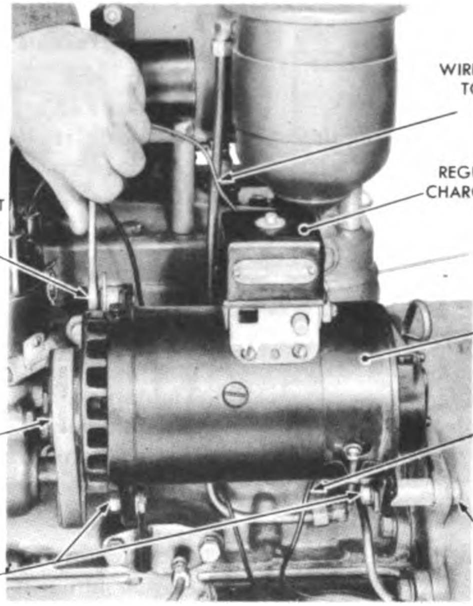


Figure 96 — Removing Battery Charging Generator

(6) Push generator toward engine, and lift off drive belt (fig. 96).

(7) Remove the two mounting cap screws, lock washers, and plain washers (½-in. open-end wrench). Also remove spacer at commutator end (fig. 96).

(8) Lift generator from engine (fig. 96).

84. GENERATOR DISASSEMBLY.

a. Equipment.

CHISEL, small
DRIVER, bushing
HAMMER
HOOK, brush arm
PLIERS
PRESS, arbor
PULLER, pulley
SCREWDRIVER, large
SCREWDRIVER, small
WRENCH, adjustable
WRENCH, open-end, 1-in.

b. Procedure.

(1) Remove four generator regulator mounting screws (screwdriver), and lock washers.

(2) Remove two generator field coil lead screws (screwdriver) from regulator, and remove regulator. NOTE: The red lead from the generator is attached to terminal "A," and the black is attached to terminal "F" (fig. 97).

ENGINE ELECTRICAL SYSTEM:
BATTERY CHARGING GENERATOR AND REGULATOR

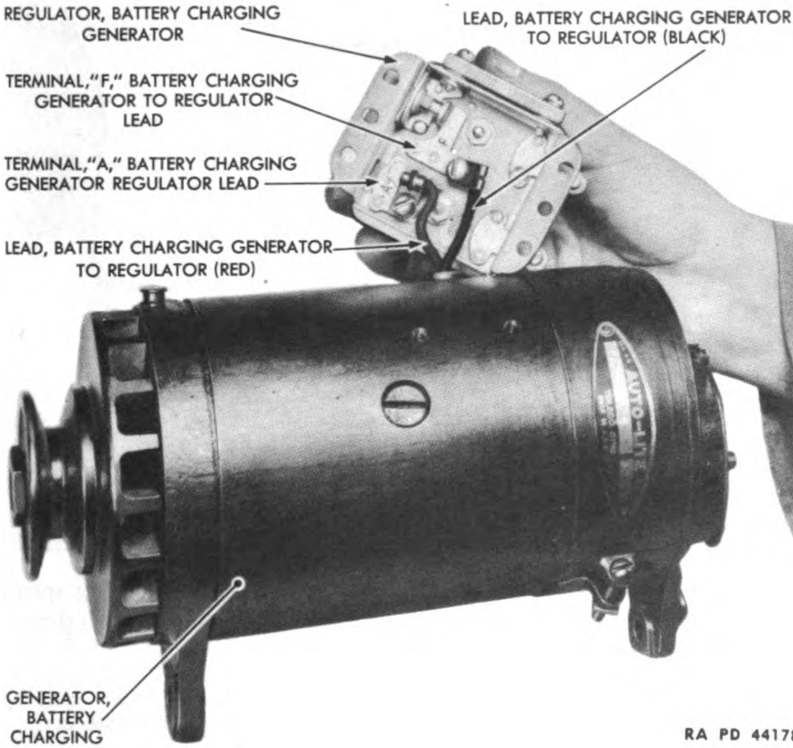


Figure 97 — Lifting Generator Regulator from Generator

(3) Remove clamp screw (screwdriver) and nut from cover band, and remove cover band from generator.

(4) Remove armature shaft nut (1-in. open-end wrench), and lift washer from drive pulley. Remove drive pulley key from armature shaft (fig. 98). Pull drive pulley from shaft (puller) (fig. 98). Remove driven pulley key and driven pulley.

(5) Remove brush lead screws and lock washers that hold brush leads to brush holder (screwdriver) (fig. 99).

(6) Make a hook on the end of a piece of wire, lift brush arms, and remove brushes from plates (fig. 99).

(7) Remove frame screws and lock washers from generator, and remove commutator end plate from frame and field assembly (screwdriver) (fig. 99).

(8) Pull brush arms and springs from brush plates (fig. 106).

(9) Remove screws and lock washers which hold main brush plate (grounded) to commutator end plate, and remove plate (screwdriver).

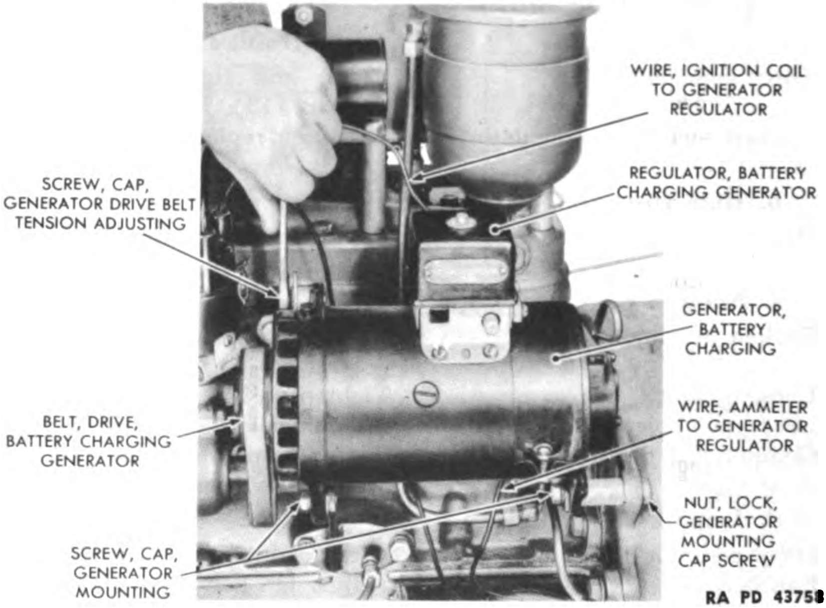


Figure 96 — Removing Battery Charging Generator

(6) Push generator toward engine, and lift off drive belt (fig. 96).

(7) Remove the two mounting cap screws, lock washers, and plain washers (½-in. open-end wrench). Also remove spacer at commutator end (fig. 96).

(8) Lift generator from engine (fig. 96).

84. GENERATOR DISASSEMBLY.

a. Equipment.

CHISEL, small
DRIVER, bushing
HAMMER
HOOK, brush arm
PLIERS
PRESS, arbor
PULLER, pulley
SCREWDRIVER, large
SCREWDRIVER, small
WRENCH, adjustable
WRENCH, open-end, 1-in.

b. Procedure.

(1) Remove four generator regulator mounting screws (screwdriver), and lock washers.

(2) Remove two generator field coil lead screws (screwdriver) from regulator, and remove regulator. NOTE: The red lead from the generator is attached to terminal "A," and the black is attached to terminal "F" (fig. 97).

ENGINE ELECTRICAL SYSTEM: BATTERY CHARGING GENERATOR AND REGULATOR

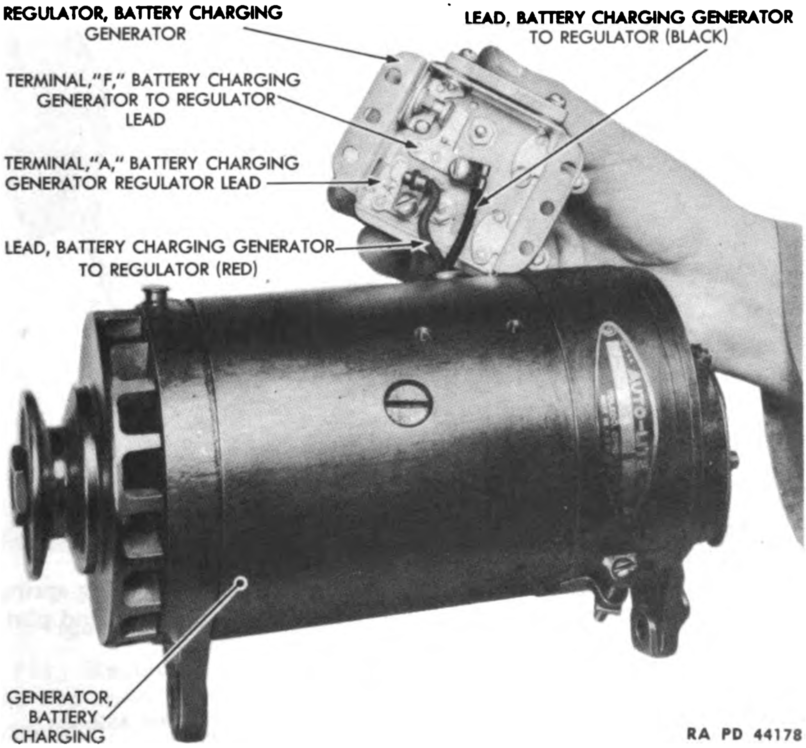


Figure 97 — Lifting Generator Regulator from Generator

(3) Remove clamp screw (screwdriver) and nut from cover band, and remove cover band from generator.

(4) Remove armature shaft nut (1-in. open-end wrench), and lift washer from drive pulley. Remove drive pulley key from armature shaft (fig. 98). Pull drive pulley from shaft (puller) (fig. 98). Remove driven pulley key and driven pulley.

(5) Remove brush lead screws and lock washers that hold brush leads to brush holder (screwdriver) (fig. 99).

(6) Make a hook on the end of a piece of wire, lift brush arms, and remove brushes from plates (fig. 99).

(7) Remove frame screws and lock washers from generator, and remove commutator end plate from frame and field assembly (screwdriver) (fig. 99).

(8) Pull brush arms and springs from brush plates (fig. 106).

(9) Remove screws and lock washers which hold main brush plate (grounded) to commutator end plate, and remove plate (screwdriver).

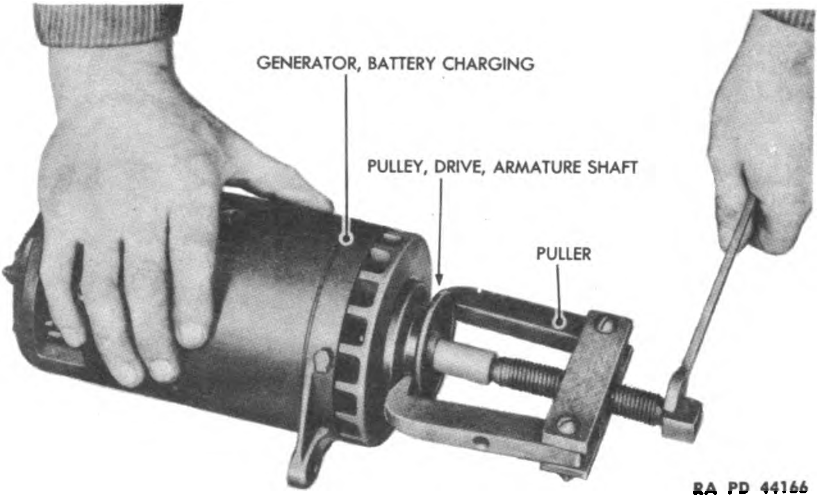


Figure 98 — Removing Drive Pulley from Armature Shaft

(10) Remove screw which holds third brush plate retaining spring, and remove spring and third brush plate from commutator end plate (screwdriver) (fig. 106).

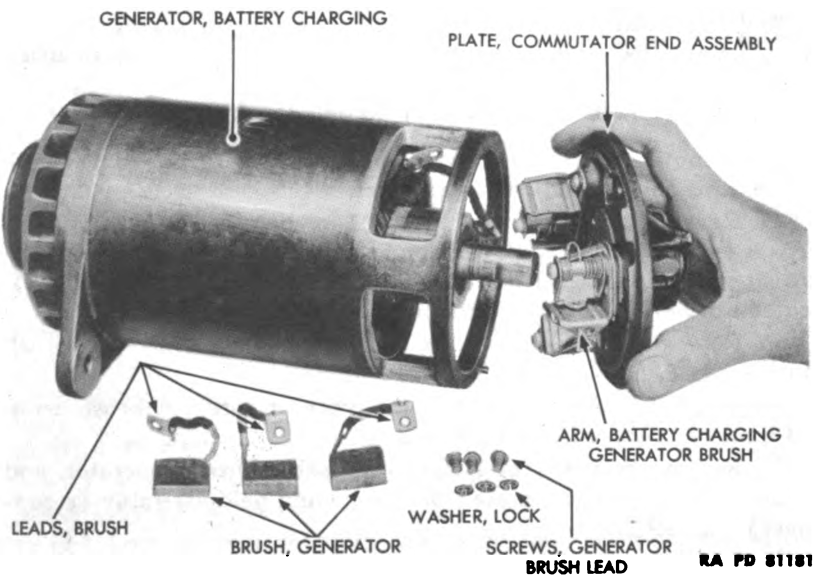


Figure 99 — Removing Commutator End Plate Assembly from Frame

ENGINE ELECTRICAL SYSTEM: BATTERY CHARGING GENERATOR AND REGULATOR

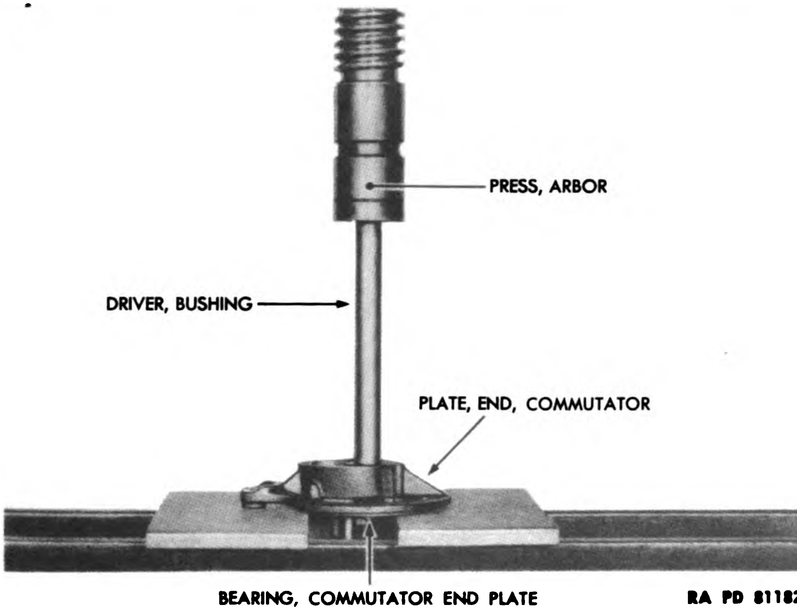


Figure 100 — Removing Commutator End Plate Bearing

(11) Remove screws and lock washers which secure commutator end cap cover to end plate, and remove cover and gasket (screwdriver).

(12) Press commutator end plate bearing (bushing driver and arbor press) from end plate (fig. 100). Commutator end plate, oil guard, and oil retaining gasket are forced from their positions while removing bearing.

(13) Remove commutator end plate oil wick cover (small chisel and hammer) and oil wick from commutator end plate.

(14) Remove drive end head and armature assembly from frame and field assembly.

(15) Remove screws (screwdriver), lock washers, and nuts which attach the two drive end head bearing retainers, felt washers, and felt guards to drive end head, and remove outer retainer, felt washer, and guard. The inner retainer, felt washer, and guard remain on armature and cannot be removed until ball bearing is pressed from the armature (fig. 106).

(16) Securely support inner race of ball bearing in an arbor press, and press ball bearing from armature shaft (driver and arbor press) (fig. 101).

(17) Remove inner felt guard, felt washer, felt washer retainer, bearing retainer from armature shaft (fig. 101).

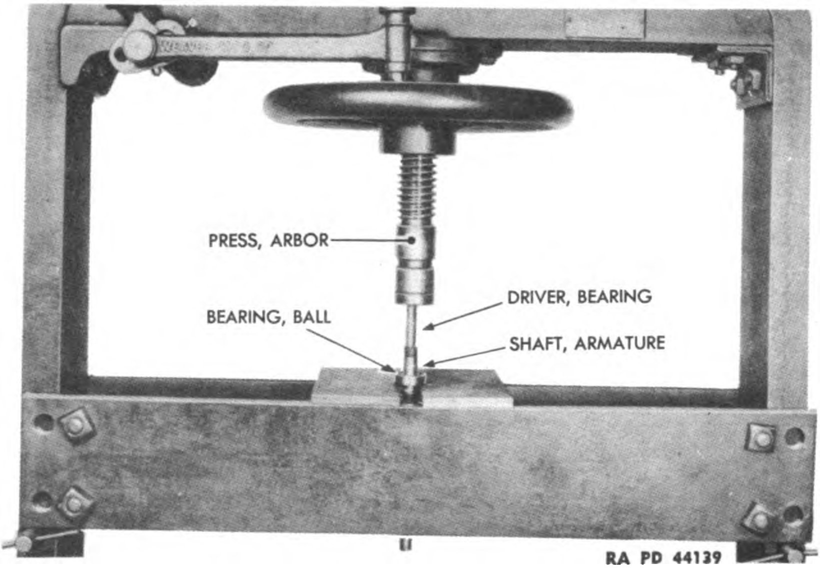


Figure 101 — Pressing Ball Bearing from Armature Shaft

(18) Remove snap ring from armature shaft (pliers and screw-driver).

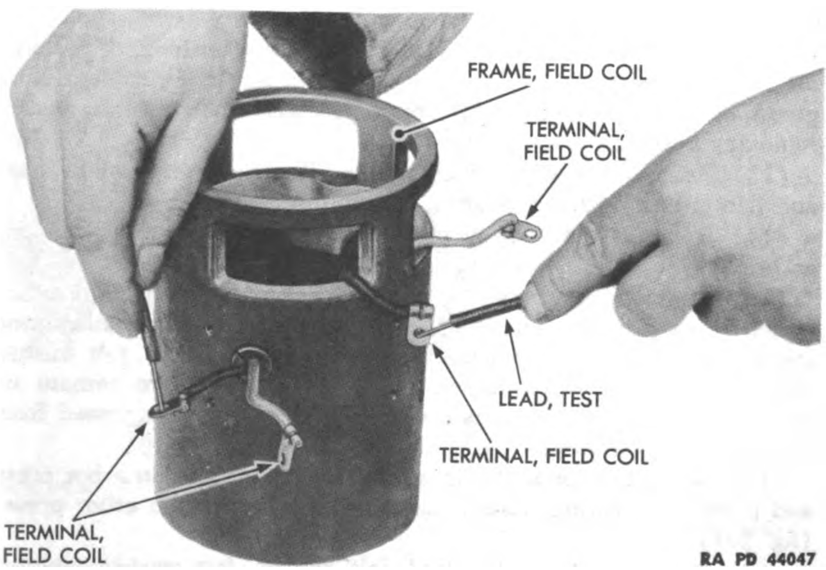


Figure 102 — Field Coil Test for Continuous Circuit

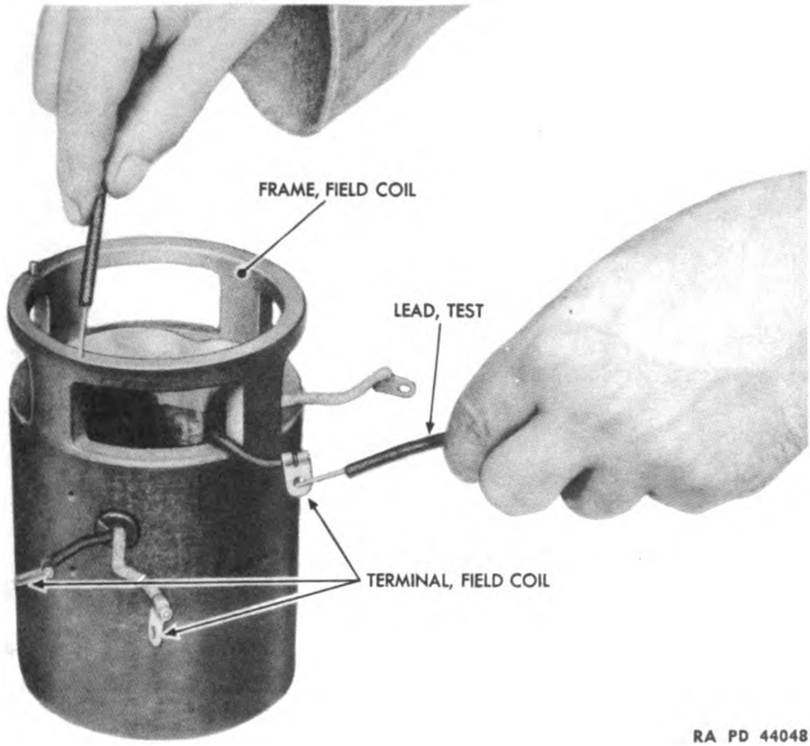


Figure 103 — Field Coil Test for Ground

(19) Remove two pole piece screws (large screwdriver and adjustable wrench) from frame.

(20) Remove insulating bushing from the frame by hand.

(21) Pull field coil leads to inside of frame, and remove field coil assembly and two pole pieces from frame.

(22) Remove pole pieces from field coil assembly.

85. GENERATOR INSPECTION AND REPAIR.

a. Equipment.

AMMETER, testing	LATHE
BATTERY, 6-volt	LEAD, test (2)
COMPRESSED AIR	PAPER, flint, class B, No. 00
GROWLER and TEST LAMP	SOLVENT, dry-cleaning
	UNDERCUTTER, mica

b. Procedure.

(1) FIELD COIL TEST FOR CONTINUOUS CIRCUIT (fig. 102).

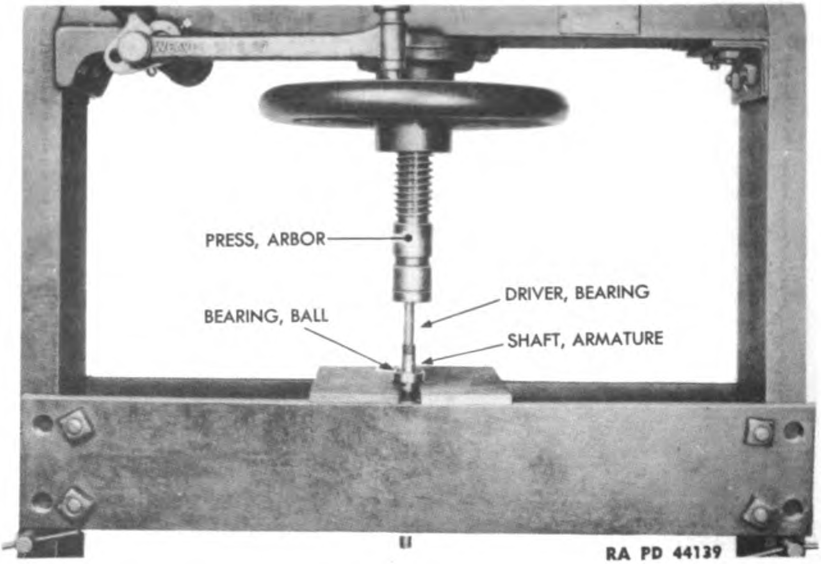


Figure 101 — Pressing Ball Bearing from Armature Shaft

(18) Remove snap ring from armature shaft (pliers and screw-driver).

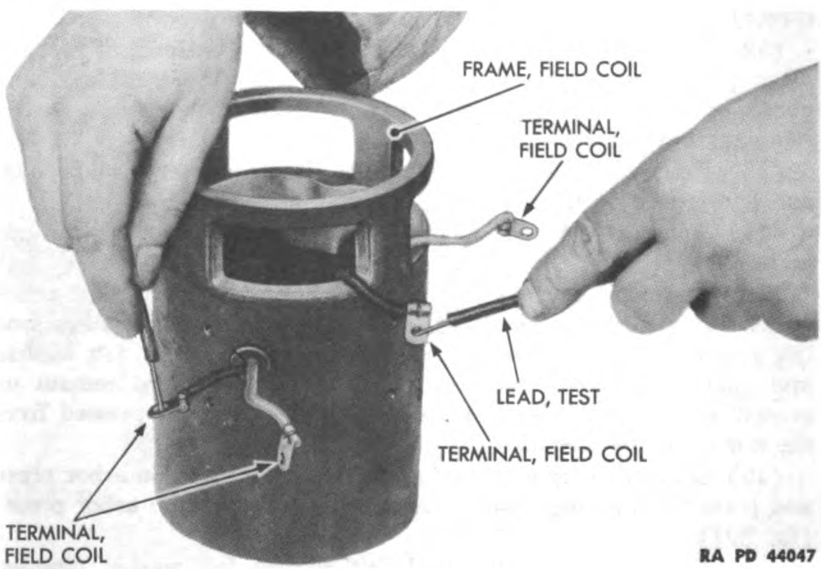


Figure 102 — Field Coil Test for Continuous Circuit

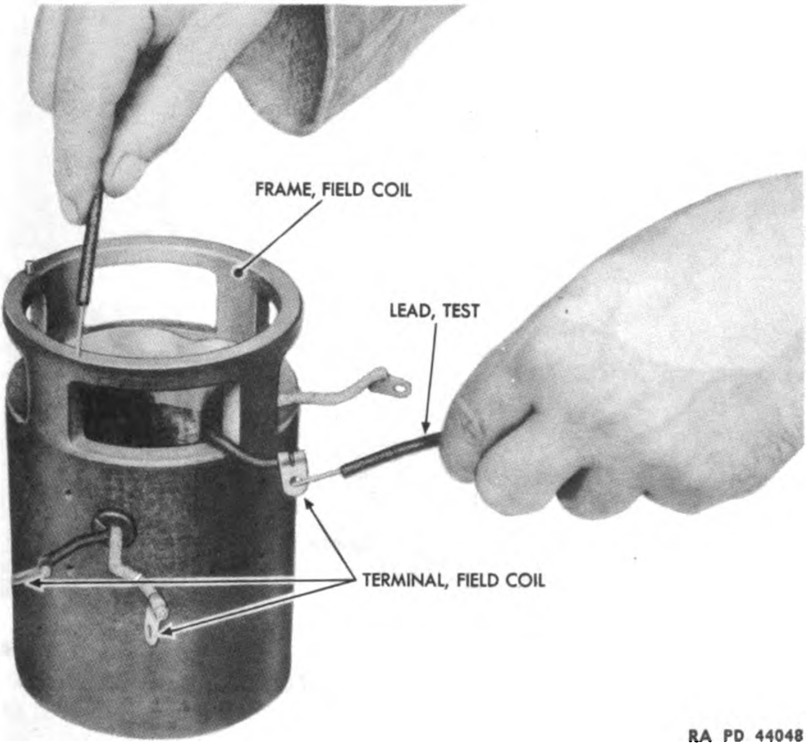


Figure 103 — Field Coil Test for Ground

(19) Remove two pole piece screws (large screwdriver and adjustable wrench) from frame.

(20) Remove insulating bushing from the frame by hand.

(21) Pull field coil leads to inside of frame, and remove field coil assembly and two pole pieces from frame.

(22) Remove pole pieces from field coil assembly.

85. GENERATOR INSPECTION AND REPAIR.

a. Equipment.

AMMETER, testing	LATHE
BATTERY, 6-volt	LEAD, test (2)
COMPRESSED AIR	PAPER, flint, class B, No. 00
GROWLER and TEST LAMP	SOLVENT, dry-cleaning
	UNDERCUTTER, mica

b. Procedure.

(1) FIELD COIL TEST FOR CONTINUOUS CIRCUIT (fig. 102).

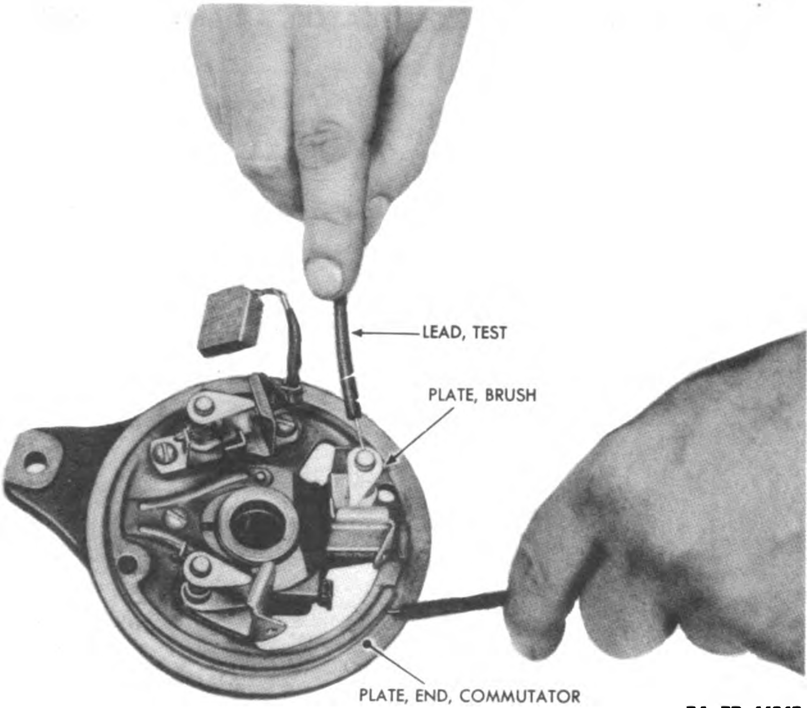


Figure 104 — Brush Plate Test for Ground

(a) Place test prod leads on the two leads from the field coils. If the test lamp lights, the field coils have no open circuit. If lamp does not light, one or both of field coils are open-circuited and should be replaced.

(b) To determine if one or both field coils are open-circuited, place one test prod lead on terminal lead from field coil, and the other on connection between field coils. If test lamp lights, field coils have no open circuit. If lamp does not light, field coil is open-circuited and must be replaced. Proceed in same manner to test other field coil.

(2) Place one end of a test lead on soldered connection, and the other end on positive terminal of battery. Place another test lead on one of the field coil terminals and on a testing ammeter. Take a reading from ammeter. Remove lead from field coil terminal and place on the other field coil terminal, and take reading from ammeter. If one field coil draws more current than the other, there is an internal short in field coil. Coil that draws the most current should be replaced.

(3) Place test prod leads, one on field coil frame and the other on a field coil terminal (fig. 103). If test lamp lights, field coil is

**ENGINE ELECTRICAL SYSTEM:
BATTERY CHARGING GENERATOR AND REGULATOR**

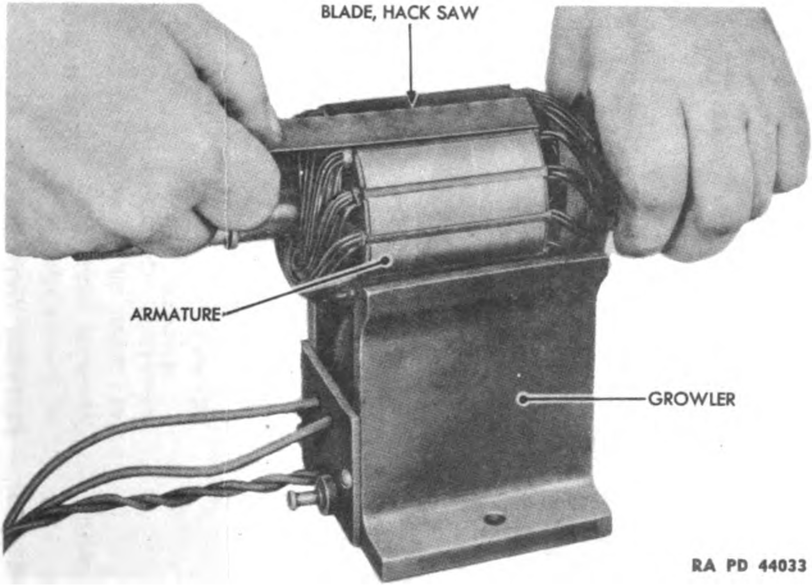


Figure 105 — Armature Test for Short

grounded and must be replaced. If test lamp does not light, field coil is satisfactory. Check other field coil in same manner.

(4) Place test prod leads, one on brush plate and the other on commutator end plate (fig. 104). If test lamp lights, positive brush holder is grounded and should be replaced. If test lamp does not light, brush holder is free of grounds.

(5) Place one test prod lead on armature and the other on one of the commutator bars. If test lamp lights, armature is grounded and should be replaced. If test lamp does not light, armature is not grounded. Proceed to test each commutator bar in turn until all have been tested.

(6) Place armature on growler and, with a hacksaw blade over armature core, rotate armature and test (fig. 105). If saw blade does not vibrate, armature has no shorts. If saw blade vibrates, armature is short-circuited. To determine whether armature windings or the commutator is shorted, clean out between commutator bars and re-check armature. If the saw blade still vibrates, armature windings are short-circuited, and armature must be replaced.

(7) Check fit of armature shaft in commutator end bearing. If bearing is worn, replace it.

(8) Clean drive end ball bearing in SOLVENT, dry-cleaning, and blow out with compressed air. Check ball bearing for wear or roughness. Replace if necessary.

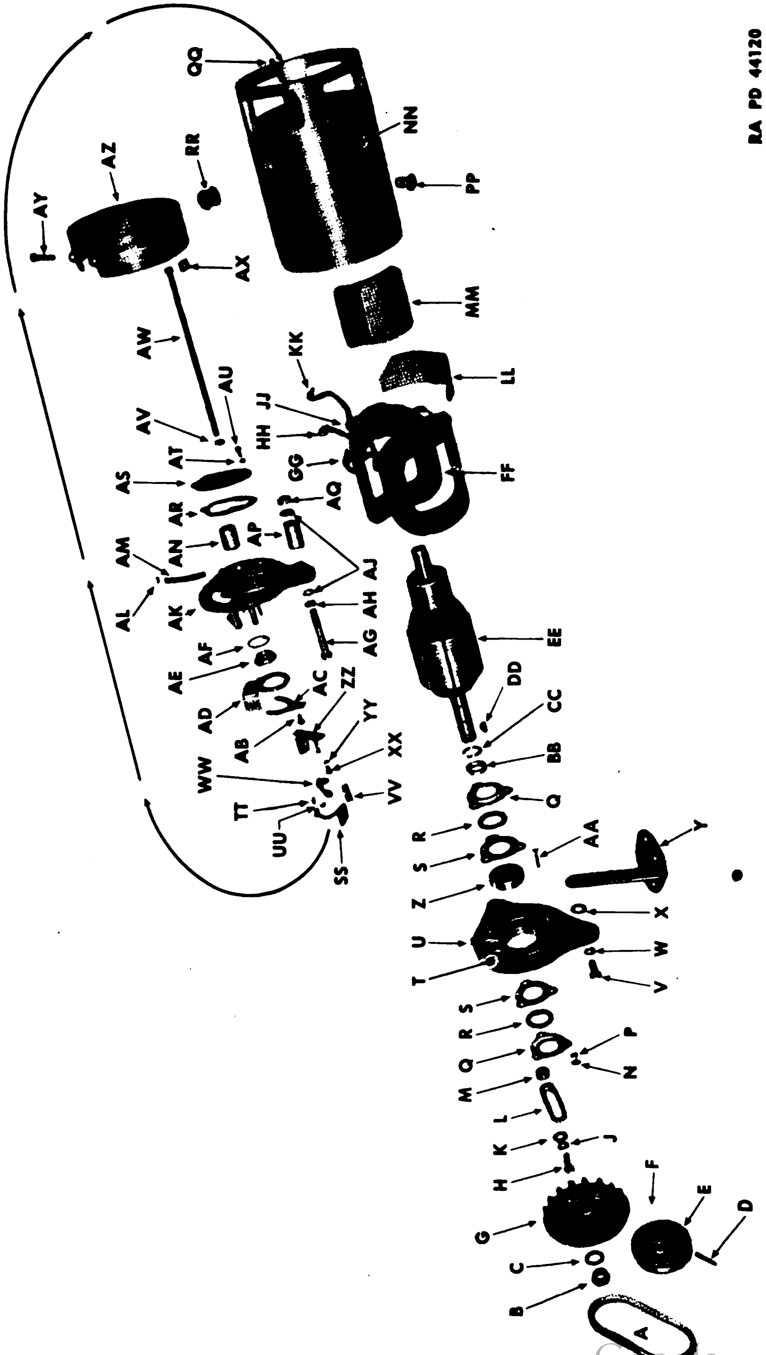


Figure 106 — Battery Charging Generator — Exploded View

ENGINE ELECTRICAL SYSTEM: BATTERY CHARGING GENERATOR AND REGULATOR

A—BELT, DRIVE
B—NUT, ARMATURE SHAFT
C—WASHER, LOCK, ARMATURE SHAFT
D—PIN, DRIVE PULLEY
E—PULLEY, DRIVE
F—KEY, DRIVE PULLEY
G—PULLEY, DRIVEN
H—SCREW, ATTACHING
J—WASHER, LOCK
K—WASHER, PLAIN
L—BRACKET, ADJUSTABLE
M—SPACER, ADJUSTABLE BRACKET
N—NUT, BEARING RETAINER SCREW
P—WASHER, LOCK, BEARING RETAINER SCREW
Q—RETAINER, BEARING
R—WASHER, FELT, DRIVE END HEAD
S—GUARD, DRIVE END HEAD FELT WASHER
T—HEAD, DRIVE END
U—OILER, DRIVE END HEAD
V—SCREW, SUPPORT BRACKET
W—WASHER, LOCK, SUPPORT BRACKET
X—WASHER, PLAIN, SUPPORT BRACKET
Y—BRACKET, SUPPORT, GENERATOR
Z—BEARING, BALL, ARMATURE

AA—SCREW, BEARING RETAINER
BB—RETAINER, FELT WASHER
CC—RING, SNAP, ARMATURE SHAFT
DD—KEY, DRIVE PULLEY
EE—ARMATURE
FF—COIL, FIELD
GG—TERMINAL, FIELD COIL
HH—TERMINAL, FIELD COIL
JJ—TERMINAL, FIELD COIL
KK—TERMINAL, FIELD COIL
LL—INSULATION, FIELD CONNECTION
MM—PIECE, POLE, FRAME
NN—FRAME
PP—SCREW, POLE PIECE
QQ—PIN, DOWEL, FRAME
RR—BUSHING, FRAME INSULATING
SS—BRUSH
TT—WASHER, LOCK, BRUSH LEAD
UU—SCREW, BRUSH LEAD
VV—SPRING, BRUSH
WW—ARM, BRUSH
XX—SCREW, BRUSH PLATE
YY—WASHER, BRUSH PLATE
ZZ—PLATE, MAIN BRUSH (GROUNDED)

AB—SCREW, PLATE RETAINING
AC—SPRING, PLATE RETAINING
AD—PLATE, THIRD BRUSH
AE—GUARD, OIL, COMMUTATOR END PLATE
AF—GASKET, COMMUTATOR END PLATE OIL RETAINING
AG—BOLT
AH—WASHER, LOCK
AJ—WASHER, PLAIN
AK—PLATE, END, COMMUTATOR
AL—COVER, END PLATE OIL WICK
AM—WICK, OIL, END PLATE
AN—BEARING, END PLATE, COMMUTATOR
AP—SPACER, GENERATOR
AQ—NUT
AR—GASKET, COMMUTATOR END PLATE COVER
AS—COVER, END CAP
AT—WASHER, END CAP
AU—SCREW, END CAP COVER
AV—WASHER, LOCK, FRAME SCREW
AW—SCREW, FRAME
AX—NUT, HEAD BAND
AY—SCREW, HEAD BAND
AZ—BAND, HEAD

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Legend for Figure 106 — Battery Charging Generator — Exploded View

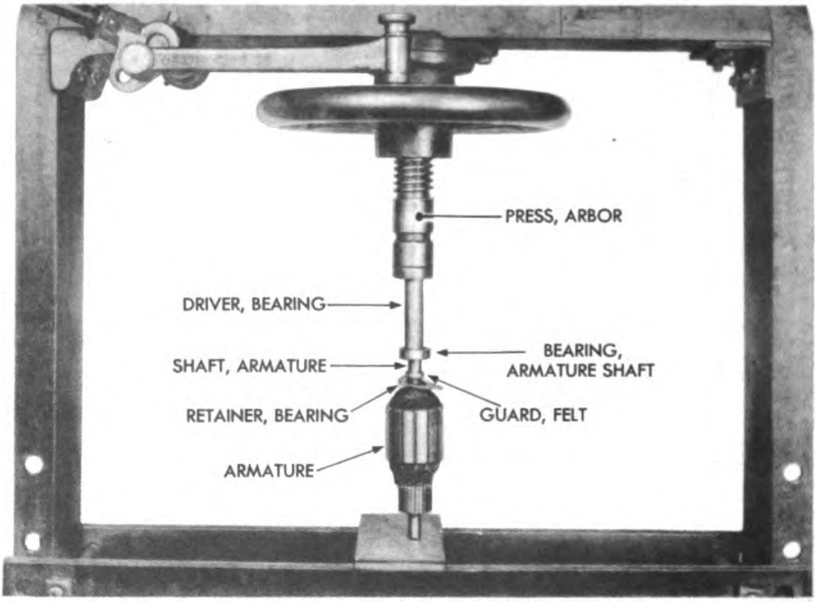

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Figure 107 — Pressing Bearing on Armature Shaft

(9) Check armature to commutator leads. See that they are properly soldered to commutator.

(10) Check the commutator for roughness, and, if rough, turn it down on a lathe until it is thoroughly clean, after which sand off with PAPER, flint, class B, No. 00. Undercut the mica and again check armature for shorts on growler (fig. 105).

(11) Check to see that brush springs have enough tension to hold brushes snugly against the commutator. Replace if necessary.

(12) Check brushes for wear and condition. Replace if worn to half their original length, or if broken.

86. GENERATOR ASSEMBLY.

a. Equipment.

DRIVER, bushing
HAMMER
HOOK, brush arm
PLIERS
PRESS, arbor
SCREWDRIVER, heavy-duty
SCREWDRIVER, small
WRENCH, adjustable
WRENCH, open-end, 1-in.

b. Procedure (fig. 106).

(1) Assemble field coil assembly (FF) into frame (NN) and bring the field coil leads (GG, HH, JJ, and KK) to outside of frame (NN).

**ENGINE ELECTRICAL SYSTEM:
BATTERY CHARGING GENERATOR AND REGULATOR**

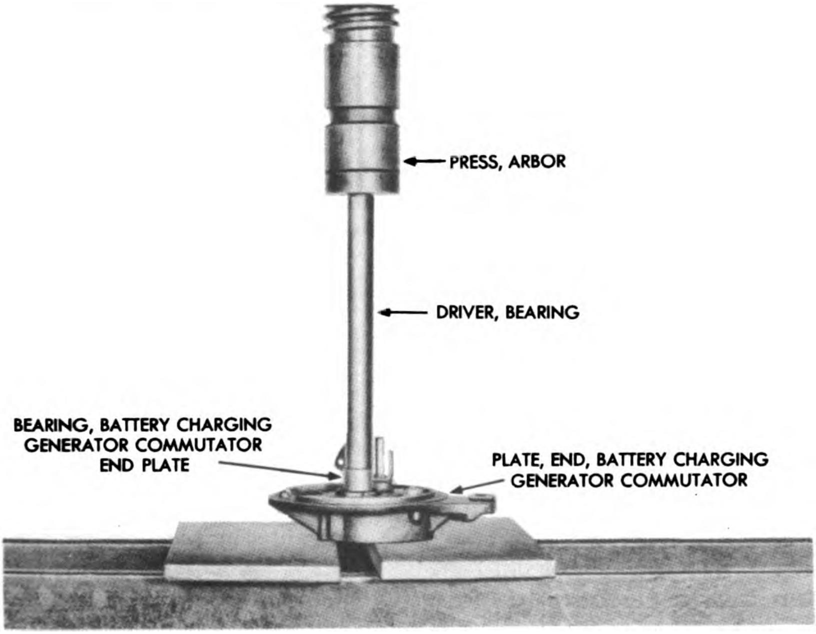

Figure 108 — Pressing Commutator End Plate Bearing into End Plate

(2) Assemble 2-pole pieces (MM) to inside of field coil (FF) and secure with pole piece screws (PP) (heavy-duty screwdriver and adjustable wrench).

(3) Assemble frame insulating bushing (RR) over field coil leads (GG, HH, JJ, and KK) and into frame (NN).

(4) Assemble snap ring (CC) to shaft of armature (EE) (pliers and screwdriver).

(5) Assemble felt retainer (BB), inner bearing retainer (Q), felt washer (R), and felt washer guard (S) onto armature shaft.

(6) Support armature (EE) in an arbor press, and press bearing (Z) (arbor press and bushing driver) on armature shaft. CAUTION: Pressure must be against inner race, as pressing on outer race will damage bearing (fig. 107).

(7) Assemble armature and bearing assembly to drive end head (T), and place outer felt guard (S), felt washer (R), and bearing retainer (Q) over armature shaft. Secure in place with three screws (AA) (screwdriver), lock washers (P), and nuts (N).

(8) Press bearing (AN) (arbor press and bushing driver) into commutator end plate (AK). Assemble oil retaining gasket (AF) over oil guard (AE), and tap (hammer) into place in end plate (AK) (fig. 108).

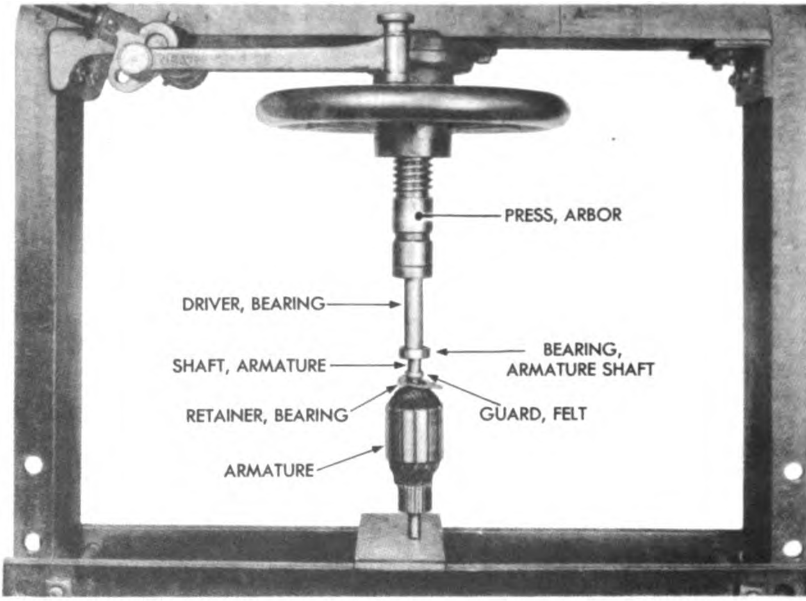

Figure 107 — Pressing Bearing on Armature Shaft

(9) Check armature to commutator leads. See that they are properly soldered to commutator.

(10) Check the commutator for roughness, and, if rough, turn it down on a lathe until it is thoroughly clean, after which sand off with PAPER, flint, class B, No. 00. Undercut the mica and again check armature for shorts on growler (fig. 105).

(11) Check to see that brush springs have enough tension to hold brushes snugly against the commutator. Replace if necessary.

(12) Check brushes for wear and condition. Replace if worn to half their original length, or if broken.

86. GENERATOR ASSEMBLY.

a. Equipment.

DRIVER, bushing
HAMMER
HOOK, brush arm
PLIERS
PRESS, arbor
SCREWDRIVER, heavy-duty
SCREWDRIVER, small
WRENCH, adjustable
WRENCH, open-end, 1-in.

b. Procedure (fig. 106).

(1) Assemble field coil assembly (FF) into frame (NN) and bring the field coil leads (GG, HH, JJ, and KK) to outside of frame (NN).

ENGINE ELECTRICAL SYSTEM:
BATTERY CHARGING GENERATOR AND REGULATOR

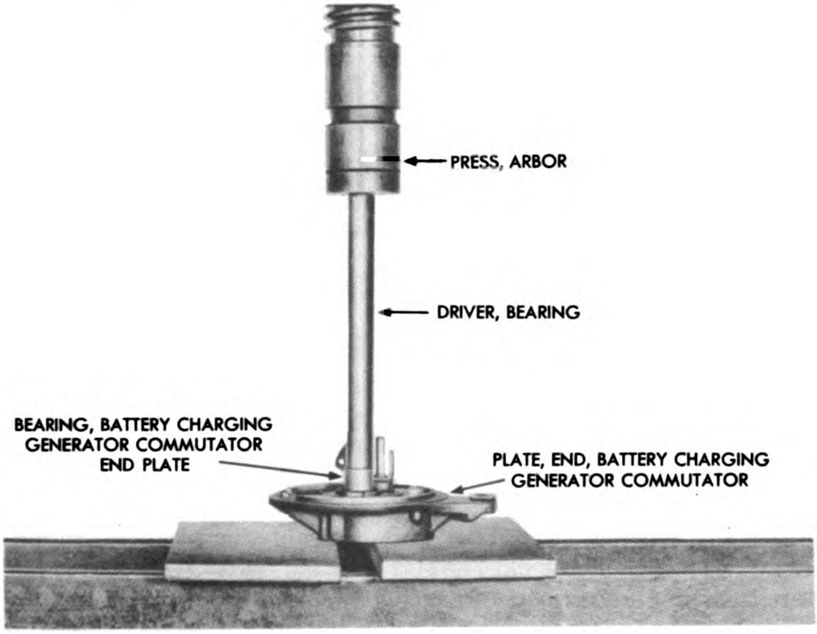

Figure 108 — Pressing Commutator End Plate Bearing into End Plate

(2) Assemble 2-pole pieces (MM) to inside of field coil (FF) and secure with pole piece screws (PP) (heavy-duty screwdriver and adjustable wrench).

(3) Assemble frame insulating bushing (RR) over field coil leads (GG, HH, JJ, and KK) and into frame (NN).

(4) Assemble snap ring (CC) to shaft of armature (EE) (pliers and screwdriver).

(5) Assemble felt retainer (BB), inner bearing retainer (Q), felt washer (R), and felt washer guard (S) onto armature shaft.

(6) Support armature (EE) in an arbor press, and press bearing (Z) (arbor press and bushing driver) on armature shaft. CAUTION: Pressure must be against inner race, as pressing on outer race will damage bearing (fig. 107).

(7) Assemble armature and bearing assembly to drive end head (T), and place outer felt guard (S), felt washer (R), and bearing retainer (Q) over armature shaft. Secure in place with three screws (AA) (screwdriver), lock washers (P), and nuts (N).

(8) Press bearing (AN) (arbor press and bushing driver) into commutator end plate (AK). Assemble oil retaining gasket (AF) over oil guard (AE), and tap (hammer) into place in end plate (AK) (fig. 108).

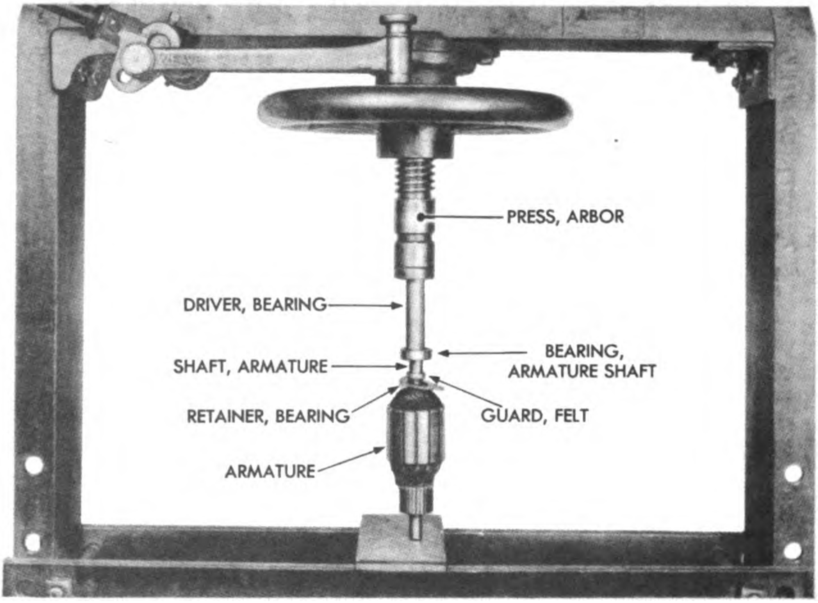

Figure 107 — Pressing Bearing on Armature Shaft

(9) Check armature to commutator leads. See that they are properly soldered to commutator.

(10) Check the commutator for roughness, and, if rough, turn it down on a lathe until it is thoroughly clean, after which sand off with PAPER, flint, class B, No. 00. Undercut the mica and again check armature for shorts on growler (fig. 105).

(11) Check to see that brush springs have enough tension to hold brushes snugly against the commutator. Replace if necessary.

(12) Check brushes for wear and condition. Replace if worn to half their original length, or if broken.

86. GENERATOR ASSEMBLY.

a. Equipment.

DRIVER, bushing
HAMMER
HOOK, brush arm
PLIERS
PRESS, arbor
SCREWDRIVER, heavy-duty
SCREWDRIVER, small
WRENCH, adjustable
WRENCH, open-end, 1-in.

b. Procedure (fig. 106).

(1) Assemble field coil assembly (FF) into frame (NN) and bring the field coil leads (GG, HH, JJ, and KK) to outside of frame (NN).

ENGINE ELECTRICAL SYSTEM:
BATTERY CHARGING GENERATOR AND REGULATOR

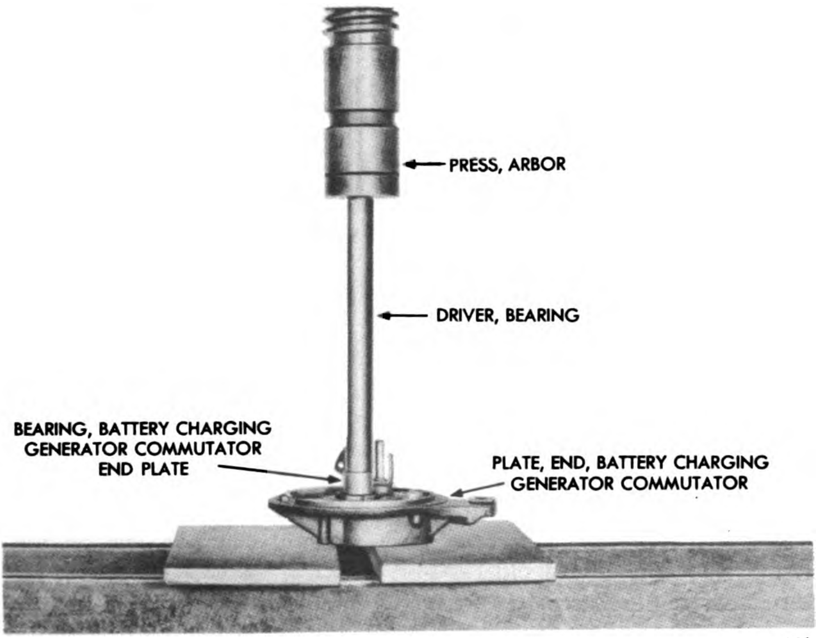

Figure 108 — Pressing Commutator End Plate Bearing into End Plate

(2) Assemble 2-pole pieces (MM) to inside of field coil (FF) and secure with pole piece screws (PP) (heavy-duty screwdriver and adjustable wrench).

(3) Assemble frame insulating bushing (RR) over field coil leads (GG, HH, JJ, and KK) and into frame (NN).

(4) Assemble snap ring (CC) to shaft of armature (EE) (pliers and screwdriver).

(5) Assemble felt retainer (BB), inner bearing retainer (Q), felt washer (R), and felt washer guard (S) onto armature shaft.

(6) Support armature (EE) in an arbor press, and press bearing (Z) (arbor press and bushing driver) on armature shaft. CAUTION: Pressure must be against inner race, as pressing on outer race will damage bearing (fig. 107).

(7) Assemble armature and bearing assembly to drive end head (T), and place outer felt guard (S), felt washer (R), and bearing retainer (Q) over armature shaft. Secure in place with three screws (AA) (screwdriver), lock washers (P), and nuts (N).

(8) Press bearing (AN) (arbor press and bushing driver) into commutator end plate (AK). Assemble oil retaining gasket (AF) over oil guard (AE), and tap (hammer) into place in end plate (AK) (fig. 108).

(9) Soak commutator end plate oil wick (AM) in OIL, engine (seasonal grade), and assemble oil wick (AM) and cover (AL) to end plate (AK).

(10) Assemble commutator end cap cover (AS) and gasket (AR) to end plate (AK), and secure in place with four screws (AU) and lock washers (AT) (screwdriver).

(11) Assemble third brush plate (AD) in its approximate position on end plate (AK), and secure in place retaining spring (AC) and screw (AB) (screwdriver) (fig. 106).

(12) Assemble main brush plate (ZZ) (grounded) to commutator end plate (AK), securing with two screws (XX) (screwdriver) and lock washers (YY).

(13) Place brush springs (VV) into brush arms (WW) and assemble to brush plate (ZZ).

(14) Place brushes (SS) in brush plates (ZZ) so that they will clear commutator when armature is assembled to frame. Attach brush lead wire terminal to brush plates with screws (UU) and washers (TT) (screwdriver).

(15) Place commutator end plate assembly in position on the frame (NN) over dowel pin (QQ).

(16) Assemble armature and drive end head assembly to frame and commutator end plate.

(17) Secure commutator end plate and drive end head to frame with two frame screws (AW) (screwdriver) and lock washers (AV).

(18) Place driven pulley (G) and key (DD) in armature shaft. Install drive pulley key (F) and drive pulley (E).

(19) Assemble armature shaft lock washer (C) and nut (B) on armature shaft. Tighten nut (1-in. open-end wrench) until drive pulley (E) is forced into its proper position, and insert drive pulley pin (D).

(20) Assemble two generator field coil leads to generator regulator, securing with two screws (screwdriver) and lock washers. NOTE: The red lead from generator is attached to terminal "A", and the black lead to terminal "F" (fig. 97).

(21) Secure generator regulator to generator with four screws and lock washers.

87. GENERATOR INSTALLATION.

a. Equipment.

SCREWDRIVER
WRENCH, open-end, ½-in.
WRENCH, open-end, ⅝-in.

b. Procedure.

(1) Place battery charging generator in position on engine (fig. 96).

ENGINE ELECTRICAL SYSTEM: BATTERY CHARGING GENERATOR AND REGULATOR

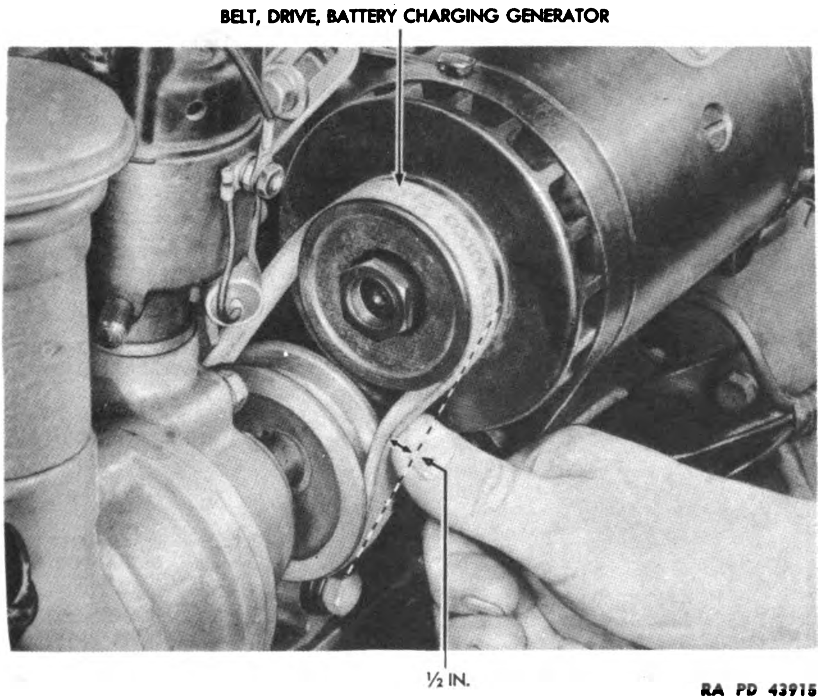

Figure 109 — Adjusting Generator Drive Belt Tension

(2) Install the two generator mounting cap screws, lock washers, and plain washers, placing the spacer between the commutator end plate and the tapped lug on the bell housing (fig. 96). Tighten cap screws finger tight.

(3) Place drive belt on its pulleys (fig. 96).

(4) Install adjustable bracket spacer (M), plain washer (K), lock washer (J), and cap screw (H) fingertight (fig. 106).

(5) Test tension of drive belt by pushing midway between pulleys (fig. 109). Push generator toward engine, or pull generator away from engine, until play of one-half inch is obtained. Tighten adjusting cap screw and mounting cap screws (½-in. open-end wrench) (fig.96).

(6) Install and tighten generator mounting cap screw lock nut (⅝-in. open-end wrench) (fig. 96).

(7) Connect ammeter wire to terminal marked "B" on engine side of battery charging generator regulator (screwdriver) (fig. 110).

(8) Connect ignition coil wire to terminal marked "T" on engine side of battery charging generator regulator (screwdriver) (fig. 110).

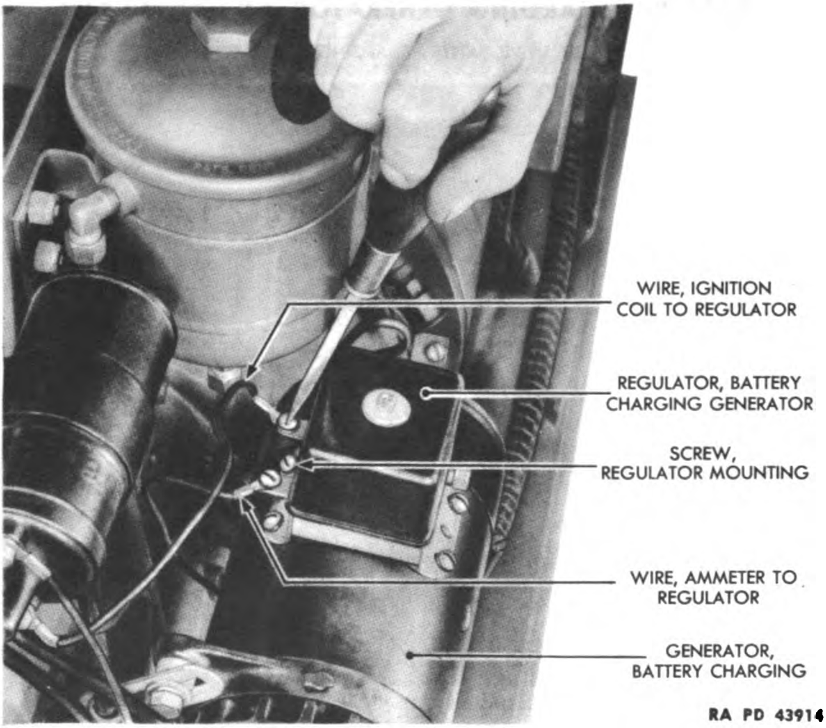

Figure 110 — Removing Generator Regulator

88. GENERATOR REGULATOR REMOVAL.

a. Equipment.

SCREWDRIVER

b. Procedure.

(1) Disconnect ignition coil wire from regulator (fig. 110).

(2) Disconnect ammeter wire from regulator (fig. 110).

(3) Remove the four regulator mounting screws and lock washers (fig. 110).

(4) Lift regulator from generator.

(5) Disconnect field and armature leads from bottom of regulator (fig. 97).

89. GENERATOR REGULATOR DISASSEMBLY.

a. Equipment.

PLIERS, thin-nosed SCREWDRIVER

b. Procedure.

(1) Remove cover nut (screwdriver) and lift cover from regulator (fig. 112).

ENGINE ELECTRICAL SYSTEM: BATTERY CHARGING GENERATOR AND REGULATOR

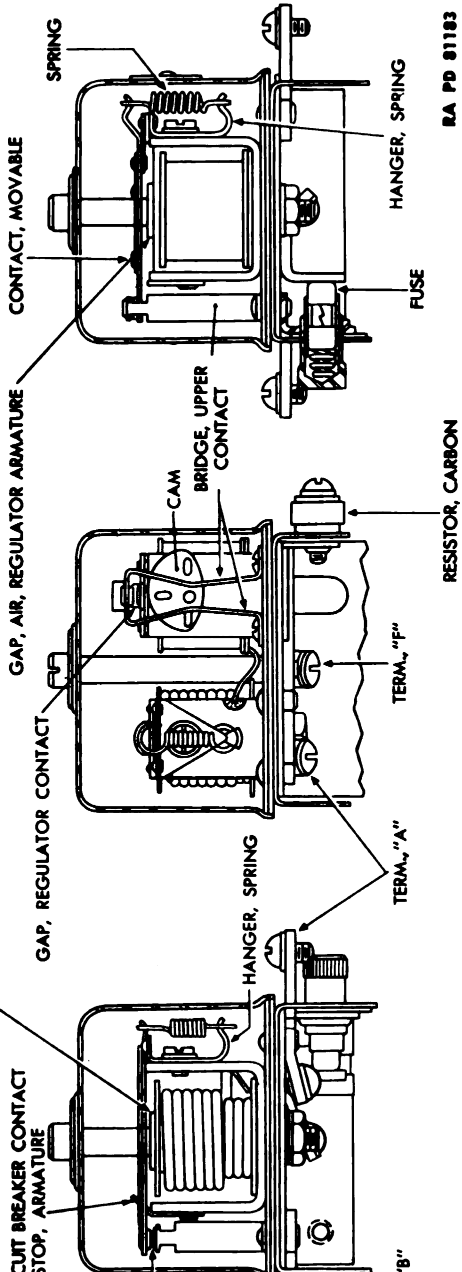

Figure 111 — Adjustment of Generator Regulator

(2) Remove carbon resistor screws (screwdriver), lock washers, and insulating washers, and lift off carbon resistor (fig. 112).

(3) Remove fuse cap, fuse insulation, and fuse from regulator body (thin-nosed pliers).

90. GENERATOR REGULATOR INSPECTION AND REPAIR.

a. Equipment.

CARBON TETRA-CHLORIDE
FILE (ST-290)
GAGE, set, feeler, 0.005- to 0.050-in.
OHMMETER
PLIERS, thin-nosed
SOLDERING EQUIPMENT
TAPE, linen

b. Procedure.

(1) Examine for evidence of burning, or abnormally high temperatures, at the coils, contacts, insulation, external terminals, or other points.

(2) Examine for loose connections resulting from poor soldering. Resolder loose connections.

(3) Examine for loose nuts on bottom of magnet cores, loose rivets, or screws. All nuts and screws must have lock washers.

(4) CONTACTS. Clean all contacts by filing, parallel with length of the armature, with a very fine file (ST-290) so that they are free from pits and burning. Clean points with CARBON TETRA-CHLORIDE to remove any dirt or grease. Pull a piece of clean linen tape between contacts to remove any residue.

(5) CARBON RESISTOR. Check resistance of the carbon resistor with an ohmmeter. It must read 7 ohms, plus or minus 5 percent. Replace if necessary.

(6) CIRCUIT BREAKER ARMATURE AIR GAP. Check circuit breaker armature air gap (feeler gage). This check is made with contacts closed, and is adjusted by raising or lowering stationary contact. Adjust to 0.010 to 0.030 of an inch (fig. 111).

(7) CIRCUIT BREAKER CONTACT GAP. Check circuit breaker contact gap (feeler gage). It must be 0.015 to 0.045 of an inch. Adjust by bending armature stop (fig. 111).

(8) REGULATOR ARMATURE AIR GAP. Check regulator armature air gap (feeler gage). It must be 0.044 to 0.046 of an inch. Measure gap with regulator contact closed. Adjust by raising or lowering upper contact, by expanding or contracting the bridge holding upper contact (fig. 111).

(9) CHECK REGULATOR CONTACT GAP. It must have a 0.005-inch minimum gap. Adjust by turning brass cam (pliers) (fig. 111).

**ENGINE ELECTRICAL SYSTEM:
BATTERY CHARGING GENERATOR AND REGULATOR**

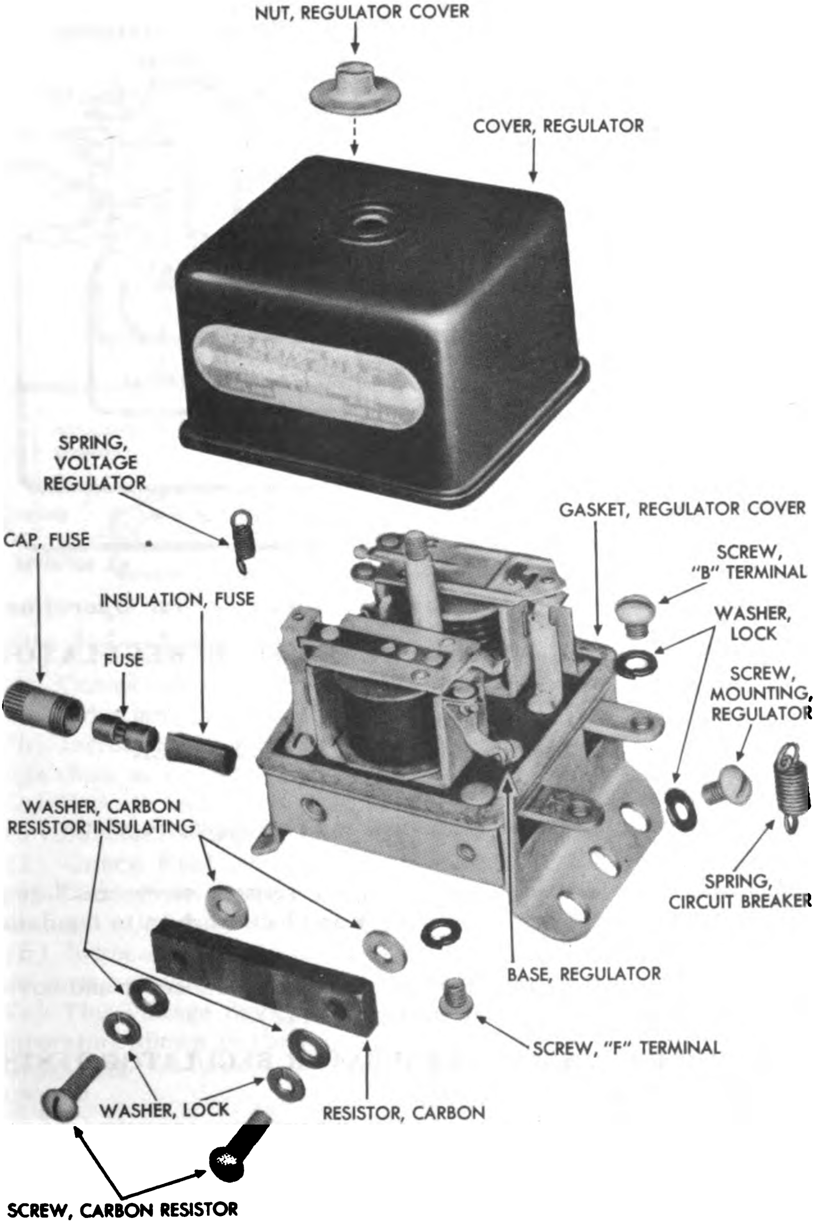

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Figure 112 — Generator Regulator — Exploded View

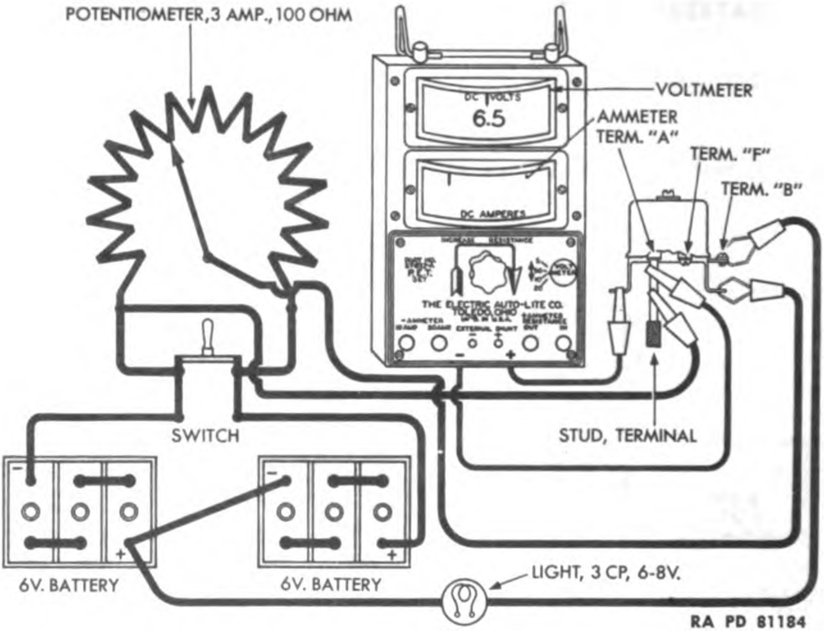


Figure 113 — Testing Generator Regulator — First Operation

91. BATTERY CHARGING GENERATOR REGULATOR ASSEMBLY.

a. Equipment.

PLIERS, thin-nosed | SCREWDRIVER

b. Procedure.

(1) Assemble fuse, fuse insulation, and fuse cap to regulator body (pliers) (fig. 112).

(2) Assemble carbon resistor, carbon resistor screw insulating washers, and two screws (screwdriver) and lock washers to regulator body (fig. 112).

(3) Place gasket on regulator body and assemble cover and cover nut (screwdriver) to regulator body (fig. 112).

92. BATTERY CHARGING GENERATOR REGULATOR TESTS.

a. Equipment.

AMMETER
BATTERY, 6-volt (2)
LAMP, 3-cp, 6- to 8-volt
LEAD
POTENTIOMETER, 3-amp, 100-ohm
VOLTMETER
WIRE

b. Procedure.

(1) CHECK CIRCUIT BREAKER OPERATION.

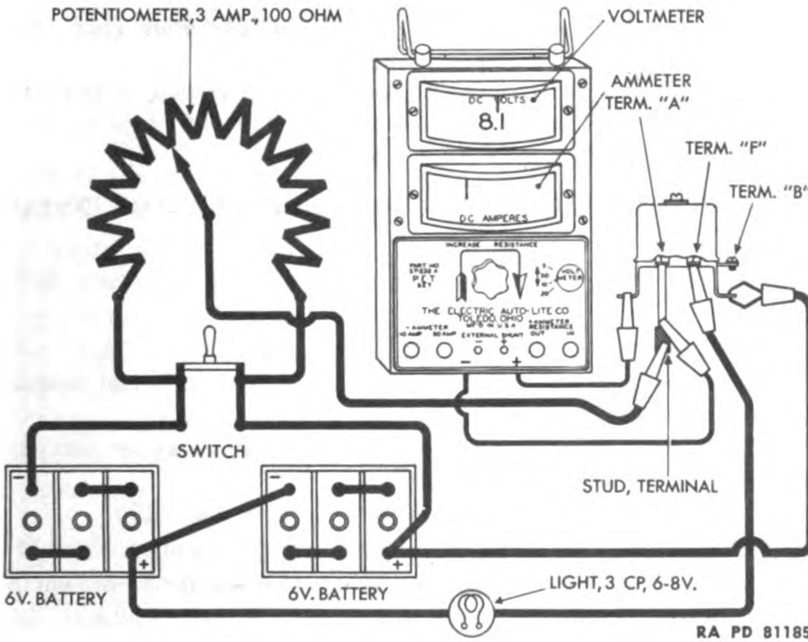


Figure 114 — Testing Generator Regulator — Second Operation

(a) Connect a voltmeter, ammeter, potentiometer, two 6-volt batteries, and a lamp, in series as per diagram (fig. 113).

(b) Increase voltage from zero and note voltage at which contact points close, as indicated by the lamp lighting (fig. 113).

(c) Voltage must be 6.4 to 7.0 volts. Adjust circuit breaker gap until voltmeter reading is within these limits (par. 90 **b** (6) and (7)).

(2) CHECK REGULATOR OPERATION.

(a) Connect a voltmeter, ammeter, potentiometer, two 6-volt batteries, and a lamp, in series as per diagram (fig. 114).

(b) Increase voltage from zero, and note voltage at which contacts open as indicated by lamp dimming or going out.

(c) This voltage figure must be within the specifications and at temperature shown in the following scale:

TEMPERATURE Fahrenheit	VOLTAGE High	Low	Ideal
50	8.40	7.90	8.15
60	8.32	7.82	8.07
70	8.25	7.75	8.00
80	8.18	7.68	7.93
90	8.10	6.60	7.85
100	8.03	7.53	7.78
110	7.96	6.46	7.71

(d) Adjust the regulator movable contact spring tension by bending spring hanger until readings fall within above scale (par. 90 **b** (8) and (9)).

(e) Reduce voltage and check contact closing voltage as indicated by lamp lighting. This voltage reading must be from 1.8 to 2.0 volts. Adjust gap by turning brass cam (fig. 111).

93. BATTERY CHARGING GENERATOR REGULATOR INSTALLATION.

a. Equipment.

SCREWDRIVER

b. Procedure.

(1) Attach generator field lead (red wire) to terminal marked "A" on bottom of regulator.

(2) Attach generator armature lead (black wire) to terminal marked "F" on bottom of regulator.

(3) Place regulator in position on generator (fig. 110).

(4) Install the four mounting screws and lock washers (fig. 110).

(5) Attach ignition coil wire to terminal marked "T" on engine side of battery regulator.

(6) Attach ammeter wire to terminal marked "B" on engine side of regulator.

Section XII

ENGINE ELECTRICAL SYSTEM: IGNITION

Paragraph

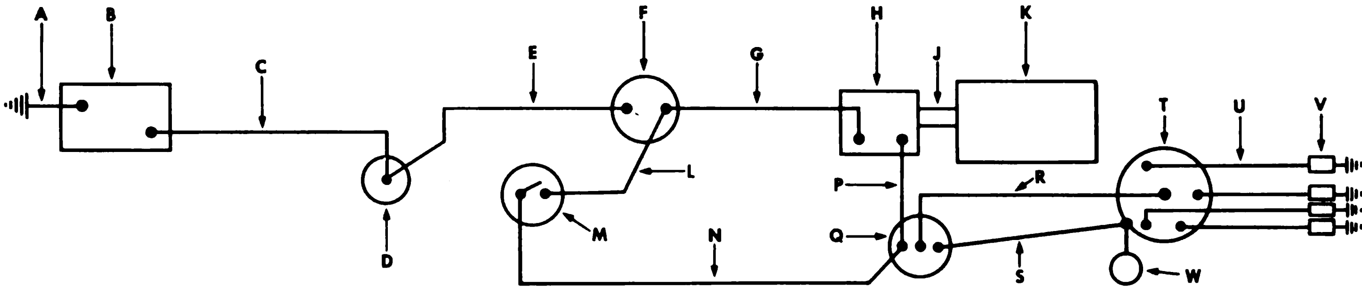
94. ENGINE IGNITION SYSTEM DESCRIPTION.

a. The engine ignition system consists of a coil, ignition distributor, condenser, spark plugs, and connecting wires. Its function is to provide electric current for operation of the engine.

b. The ignition coil is a self-contained unit consisting of an iron core around which are wound a few turns of wire to form the primary circuit, and several turns of wire to form the secondary circuit. The core and wires are enclosed in a sealed case to form the complete coil. Its function is to step up the low-tension current of the primary circuit to the high-tension current of the secondary circuit, which is needed to produce a spark across the points of the spark plugs by which the gasoline and air mixture in the cylinder is ignited.

c. The ignition distributor consists of a housing in which is enclosed a set of electrical contacts known as breaker points. A vertical shaft, driven by a gear on the engine camshaft, extends through the distributor housing. A cam is attached to this shaft within the housing, and is the means by which the breaker points are opened at proper intervals. Another contact, known as a rotor, is attached to the upper end of this shaft. A cap is attached to the top of the housing, and provides the means of connecting wires from the distributor to the spark plugs. The function of the distributor is to distribute high-tension electric current from the coil to the spark plugs at the instant it is needed to ignite the gasoline and air mixture in the cylinder.

d. A condenser is mounted on the lower half of the distributor and its wire is attached to a terminal at the top of the distributor housing. Its function is to stop the flow of low-tension current across



A—STRAP, GROUND, BATTERY
B—BATTERY
C—CABLE, BATTERY TO STARTER SWITCH
D—SWITCH, STARTER
E—WIRE, STARTER SWITCH TO AMMETER
F—AMMETER, BATTERY CHARGING GENERATOR
G—WIRE, REGULATOR TO AMMETER
H—REGULATOR, BATTERY CHARGING GENERATOR
J—LEADS, BATTERY CHARGING GENERATOR TO REGULATOR
K—GENERATOR, BATTERY CHARGING
L—WIRE, AMMETER TO IGNITION SWITCH
M—SWITCH, IGNITION
N—WIRE, IGNITION SWITCH TO IGNITION COIL
P—WIRE, REGULATOR TO IGNITION COIL
Q—COIL, IGNITION
R—CABLE, IGNITION COIL TO DISTRIBUTOR (SECONDARY)
S—WIRE, IGNITION COIL TO DISTRIBUTOR (PRIMARY)
T—DISTRIBUTOR, IGNITION
U—CABLE, IGNITION DISTRIBUTOR TO SPARK PLUG
V—PLUG, SPARK
W—CONDENSOR, IGNITION DISTRIBUTOR

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Figure 115 — Wiring Diagram of Ignition System

the distributor points the instant the points are opened. This permits more rapid energization of the secondary windings in the coil, and at the same time prevents burning the distributor breaker points.

e. The spark plug consists of a metal shell within which is located an insulator having a central electrode stem. The shell is threaded at one end to permit screwing into the cylinder head. The inner end of the shell carries a fixed, bent electrode extending from the side of the shell inward toward the central electrode stem located in the insulator. These electrodes are separated by an air gap. The outer end of the central electrode is threaded and fitted with a nut by which the wire from the distributor is attached.

95. SPECIFICATIONS.

a. Ignition Coil.

Make	Auto-Lite
Model	IG-4065
Primary voltage	6 volts

b. Distributor.

Make	Auto-Lite
Type	Full automatic
Model	IGW-4120-B
Number of cylinders	4
Direction of rotation	Right hand (viewed from top)
Breaker point gap	0.018 in.

c. Spark Plug.

Make	Titan
Model	6
Type	General purpose
Gap	0.025 in.

96. TROUBLE SHOOTING.

a. Ignition Coil.

(1) ENGINE FAILS TO FIRE.

Possible Cause	Possible Remedy
Excessive moisture on end of coil.	Wipe coil clean and dry.
Open circuit in primary or secondary circuit, or either circuit grounded outside of coil.	Check and tighten connections.
Windings grounded inside of coil.	Replace coil (par. 97).

Possible Cause	Possible Remedy
Short-circuited turns in primary or secondary windings, or high-voltage break-down in secondary windings.	Replace coil (par. 97).

(2) ENGINE MISSES DUE TO WEAK SPARK.

Internal short circuit in coil.	Replace ignition coil (par. 97).

b. Distributor.

(1) ENGINE WILL NOT START.

Breaker points not closing.	Check and adjust breaker points (par. 101). Replace if necessary (par. 100).
Breaker points worn.	Check breaker points and replace if necessary (par. 100).
Breaker point lever grounded.	Replace breaker points (par. 100).
Worn rotor or cap.	Examine and replace rotor or cap (par. 100).

(2) ENGINE MISFIRES IN ONE OR MORE CYLINDERS.

Broken cap or rotor.	Replace cap or rotor (par. 100).

(3) ENGINE MISSES AT LOW SPEED.

Breaker point gap too small.	Check and adjust gap (0.018 in.) (par. 101).

(4) ENGINE MISSES AT HIGH SPEED UNDER LOAD.

Breaker lever spring tension spring weak.	Replace breaker points (par. 100).
Breaker point gap too large.	Adjust gap (0.018 in.) (par. 101).

(5) WEAK SPARK AT PLUGS.

Breaker cam worn.	Install new cam assembly (pars. 99 and 101).
Breaker contact points worn or pitted.	Examine and replace contact points (par. 100).
Condenser shorted or disconnected.	Test connection or replace condenser (par. 100).

(6) TIMING INCORRECT OR IRREGULAR.

Breaker cam loose or wobbly.	Replace bushings in distributor housing.

c. Spark Plug.

(1) ENGINE MISSING SLIGHTLY; SLUGGISH OR IRREGULAR PERFORMANCE.

Improper spark plug gap.	Adjust spark plug gap to 0.025 inch (par. 104).

ENGINE ELECTRICAL SYSTEM: IGNITION

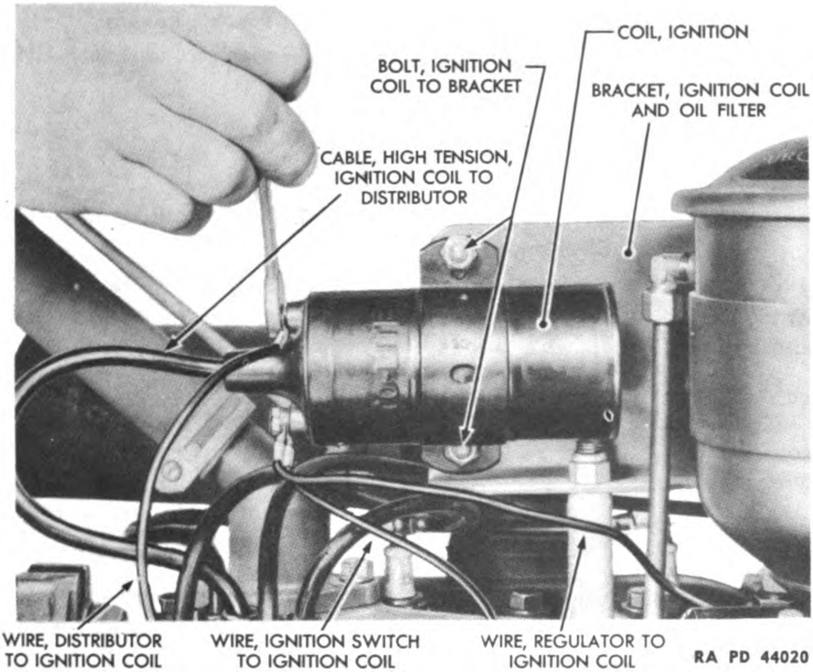


Figure 116 — Removing Ignition Coil

Possible Cause	Possible Remedy
Loose leaky spark plug threads.	Tighten or replace plugs or gaskets (par. 104).
Dirty spark plugs.	Clean and adjust spark plugs (par. 104).

(2) Failure to Give Spark.

Insulation broken.	Replace spark plug (par. 104).
Side electrode worn excessively.	Replace spark plug (par. 104).
Plug carbonized at inner end.	Clean spark plug (par. 104).
Insulation swollen, blistered, fused, or broken.	Replace spark plug (par. 104).
Electrodes showing signs of disintegration.	Replace spark plug (par. 104).
Leak around insulation, showing carbon streaks on outside.	Replace spark plug (par. 104).
Moisture on outside of spark plugs.	Wipe dry.
Points forced into contact due to careless handling when plug was installed.	Separate points and adjust gap (0.025 in.) (par. 104).

(3) ENGINE MISSING AT LOW SPEED ONLY.

Possible Cause	Possible Remedy
Insulator cracked at point outside of engine.	Replace spark plug (par. 104).

97. IGNITION COIL.

a. Removal (fig. 116).

WRENCH, open-end, 3⁄8-in.
WRENCH, open-end, 1⁄2-in.
WRENCH, open-end, 7⁄16-in.

(1) Remove distributor wire from ignition coil (3⁄8-in. open-end wrench). Using the same wrench, remove generator regulator wire and ignition switch wire from ignition coil.

(2) Pull distributor high-tension cable from ignition coil.

(3) Remove the two nuts, lock washers, and bolts, and lift ignition coil from ignition coil and oil filter bracket (1⁄2- and 7⁄16-in. open-end wrenches).

b. Inspection.

TESTER, coil

(1) Place ignition coil in a coil tester, and check spark gap while running free and under load. If spark will jump a 1⁄4-inch gap under load, coil is suitable for further service.

(2) In the absence of coil testing equipment, compare performance with another coil known to be good. Replace coil if performance is not equal to ignition coil known to be good.

c. Installation (fig. 116).

WRENCH, open-end, 3⁄8-in.
WRENCH, open-end, 1⁄2-in.
WRENCH, open-end, 7⁄16-in.

(1) Hold ignition coil in place on ignition coil and oil filter bracket. Install two bolts, lock washers, and nuts (1⁄2- and 7⁄16-in. open-end wrenches).

(2) Push distributor high-tension cable into tower on end of ignition coil.

(3) Attach distributor wire to positive terminal of ignition coil (3⁄8-in. open-end wrench).

(4) Attach generator regulator wire and ignition switch wire to negative terminal of ignition coil (3⁄8-in. open-end wrench).

98. DISTRIBUTOR REMOVAL.

a. Equipment.

SCREWDRIVER
WRENCH, open-end, 11⁄16-in.
WRENCH, open-end, 3⁄8-in.

ENGINE ELECTRICAL SYSTEM: IGNITION

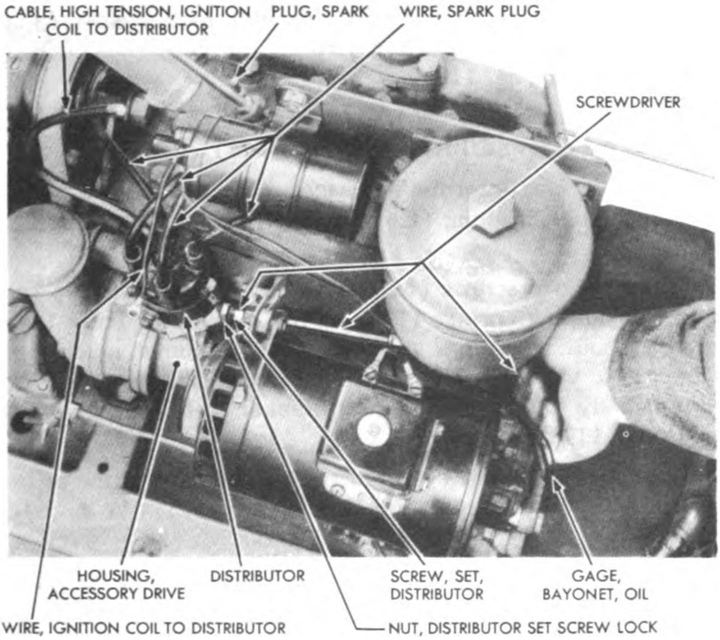


Figure 117 — Removing Distributor

b. Procedure (fig. 117).

(1) Pull spark plug wires from spark plugs. Pull ignition coil high-tension cable from ignition coil.

(2) Disconnect ignition coil wire from distributor (3/8-in. open-end wrench).

(3) Loosen distributor setscrew lock nut (11/16-in. open-end wrench).

(4) Loosen distributor setscrew (screwdriver).

(5) Lift distributor and distributor spacer from accessory drive housing.

99. DISTRIBUTOR DISASSEMBLY.

a. Equipment.

DRIVER, bushing	PUNCH
HAMMER	SCREWDRIVER
PLIERS, thin-nosed	WRENCH, open-end, 1/4-in.
PRESS, arbor	WRENCH, open-end, 3/8-in.

b. Procedure (fig. 119).

(1) Remove distributor cap (A) from body (X), and lift rotor (B) from cam (P) (fig. 119).

(2) Remove terminal nut (LL) from terminal (D), and remove lock washer (KK), condenser wire terminal, lock washer (JJ), and two terminal insulating washers (FF) from terminal (D) (3/8-in. open-end wrench) (fig. 119).

(3) Remove breaker arm of breaker point set (C) from circuit breaker plate (K), and lift out terminal (D) (fig. 119).

(4) Remove small terminal washer (G), insulation plate (F), terminal insulation bushing (H), and stop washer (E) from terminal (D) (fig. 119).

(5) Remove two screws (MM) and lock washers (NN) securing the two cap holding springs (PP) to the distributor body (X), and lift off cap holding springs (screwdriver). Remove machine screw (V) and lock washer (W) securing circuit breaker plate (K) to distributor body (X), and lift circuit breaker plate from body (screwdriver) (fig. 119).

(6) Unscrew point nut (J), and remove breaker screw of breaker point set (C) from circuit breaker plate (K) (1/4-in. open-end wrench).

(7) Remove screw (HH) and lock washer (GG) securing condenser (EE) to distributor body (X), and remove condenser (screwdriver) (fig. 119).

(8) Remove drive shaft gear pin (DD) from drive shaft gear (CC) and drive shaft (S) (punch and hammer) (fig. 119).

(9) Remove drive shaft gear (CC) and drive gear thrust washer (BB) from drive shaft (S) (fig. 119).

(10) Remove drive shaft and lower weight plate assembly (S), with governor weights (P) and upper weight plate and cam (P) attached, from body (X). Remove drive shaft thrust washer (T) from assembly (fig. 119).

(11) Remove governor weight springs (L) from lower-weight-plate-spring brackets and governor weights (R) (thin-nosed pliers) (fig. 119).

(12) Remove cam retaining spring (N) (hair pin type) (thin-nosed pliers) (fig. 119).

(13) Remove distributor cam and upper weight plate assembly (P) from distributor drive shaft (S) (fig. 119).

(14) Remove distributor governor weights (R) (fig. 119).

(15) Remove distributor governor weight spacer (Q) from distributor drive shaft (S) (fig. 119).

(16) Press drive shaft bushings (U and Z) from distributor body (X) (arbor press and bushing driver) (fig. 118).

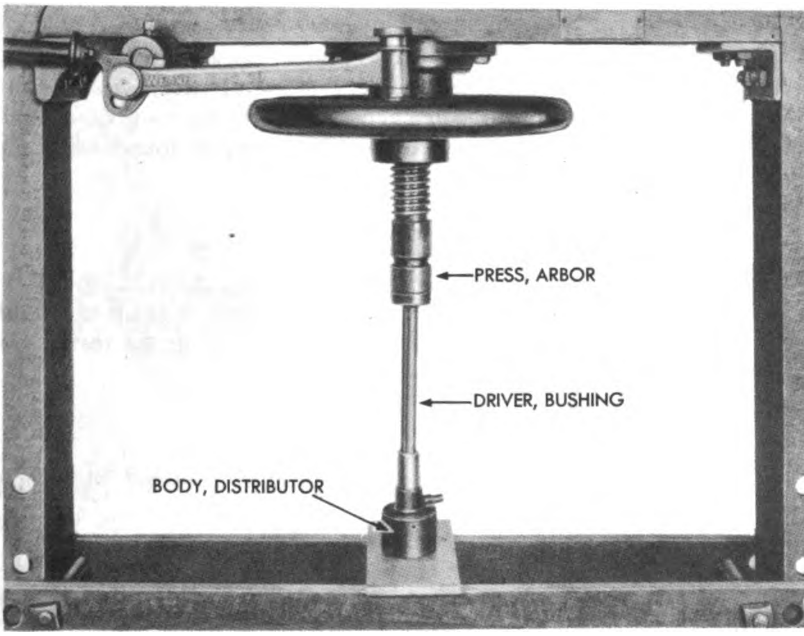


Figure 118 — Removing Bushings from Distributor Body

100. DISTRIBUTOR INSPECTION AND REPAIR.

a. Equipment.

INDICATOR, dial
LAMP, test
PRESS, arbor
SOLVENT, dry-cleaning
STONE, honing
TESTER, ignition circuit, M1

b. Procedure.

(1) DISTRIBUTOR CAP.

SOLVENT, dry-cleaning

(a) Inspect distributor cap for cracks, carbon streaks, and corroded high-tension terminals. Replace cap if any of these conditions are found.

(b) Inspect inserts on inside of cap. After a distributor has had normal use, the vertical face of the inserts becomes slightly burned. Clean with SOLVENT, dry-cleaning. *Do not file.* If burning is excessive, replace cap.

(c) Examine inserts for signs of burning on horizontal faces. If burning is noticeable at this point, it is an indication that gap between rotor and insert is too large. Replace both cap and rotor if this condition is found.

(2) ROTOR.

SOLVENT, dry-cleaning

(a) Inspect rotor for cracks, and replace if any are found. Inspect contact for evidence of burning on top of metal strip. After normal use, the end of metal strip will become slightly burned. Clean with SOLVENT, dry-cleaning. If evidence of burning is found on top of metal strip, replace rotor and cap.

(3) CONDENSER.

TESTER, ignition circuit, M1

(a) Check condenser on a Circuit Tester M1. Connect bare clip of low-tension lead to a ground on engine. Connect red clip to battery or starting switch terminal. Insert condenser in clip on tester, and attach short test lead to condenser pigtail.

(b) Place coil test switch at "test coil."

(c) Turn rotor switch on.

(d) Adjust variable spark gap to highest setting obtainable without missing.

(e) Move condenser test switch to "vehicle cord," and observe effect on high-tension output and on arcing at tester breaker contacts. Repeat test several times, changing position of condenser pigtail lead. If switching to "vehicle cord" does not result in arcing. and spark does not miss, condenser is satisfactory. If arcing does occur or spark misses, condenser is not functioning normally and must be replaced. If moving condenser lead affects action, it indicates a faulty lead and condenser must be replaced.

(4) BREAKER CONTACTS.

STONE, honing

Inspect the breaker contacts. If they are grayish in color and only slightly pitted, they need not be replaced. Make sure breaker arm turns freely on its pivot without excessive side play. Replace rough or pitted breaker contacts. If it is necessary to reinstall the old breaker contacts, hone them to a smooth flat surface on a stone before reinstalling. CAUTION: Do not file.

(5) SHAFT AND GOVERNOR.

SOLVENT, dry-cleaning

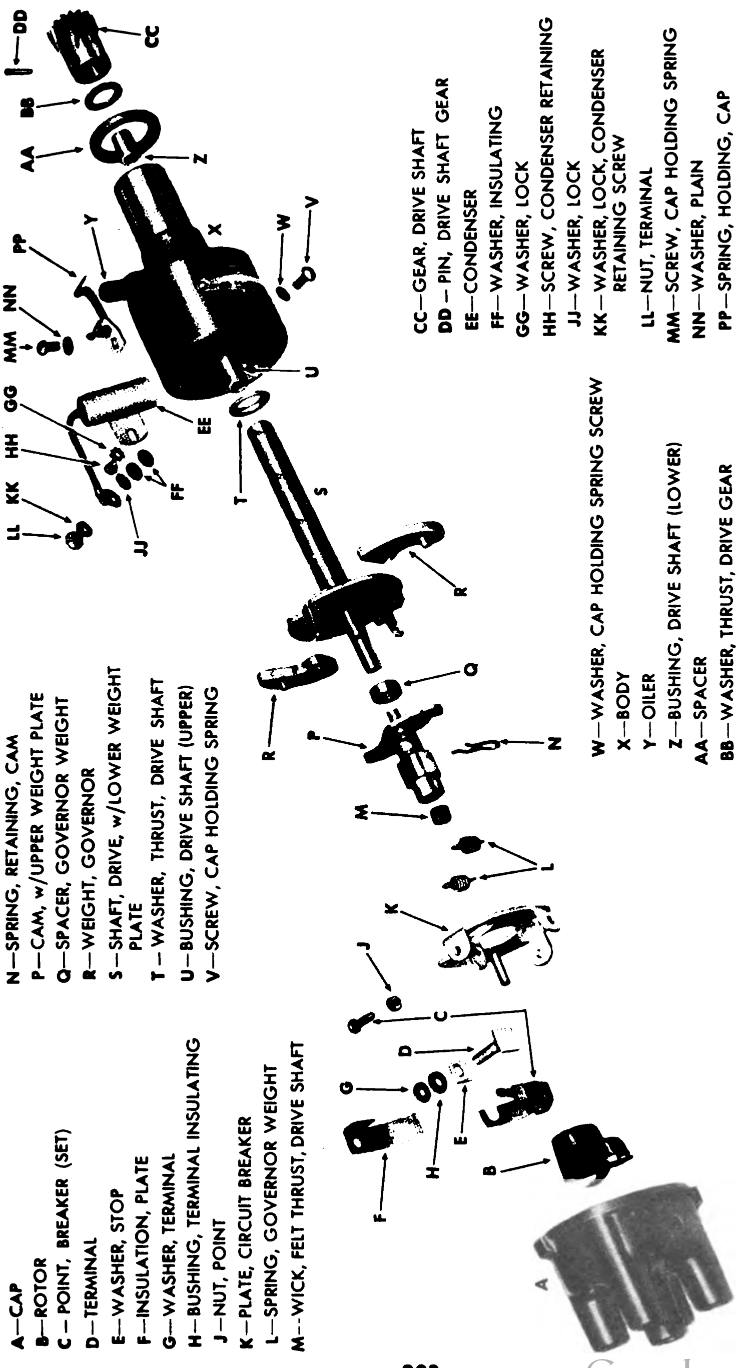
Clean the parts thoroughly in SOLVENT, dry-cleaning. Inspect governor weights and lower plate for wear. Inspect springs for distortion. Replace damaged parts.

(6) BASE.

ARBOR ( )	PRESS, arbor
INDICATOR, dial	SOLVENT, dry-cleaning

(a) Clean base thoroughly in SOLVENT, dry-cleaning, and inspect for evidence of breakage.

ENGINE ELECTRICAL SYSTEM: IGNITION



A—CAP
B—ROTOR
C—POINT, BREAKER (SET)
D—TERMINAL
E—WASHER, STOP
F—INSULATION, PLATE
G—WASHER, TERMINAL
H—BUSHING, TERMINAL INSULATING
J—NUT, POINT
K—PLATE, CIRCUIT BREAKER
L—SPRING, GOVERNOR WEIGHT
M—WICK, FELT THRUST, DRIVE SHAFT
N—SPRING, RETAINING, CAM
P—CAM, w/UPPER WEIGHT PLATE
Q—SPACER, GOVERNOR WEIGHT
R—WEIGHT, GOVERNOR
S—SHAFT, DRIVE, w/LOWER WEIGHT PLATE
T—WASHER, THRUST, DRIVE SHAFT
U—BUSHING, DRIVE SHAFT (UPPER)
V—SCREW, CAP HOLDING SPRING
W—WASHER, CAP HOLDING SPRING SCREW
X—BODY
Y—OILER
Z—BUSHING, DRIVE SHAFT (LOWER)
AA—SPACER
BB—WASHER, THRUST, DRIVE GEAR
CC—GEAR, DRIVE SHAFT
DD—PIN, DRIVE SHAFT GEAR
EE—CONDENSER
FF—WASHER, INSULATING
GG—WASHER, LOCK
HH—SCREW, CONDENSER RETAINING
JJ—WASHER, LOCK
KK—WASHER, LOCK, CONDENSER RETAINING SCREW
LL—NUT, TERMINAL
MM—SCREW, CAP HOLDING SPRING
NN—WASHER, PLAIN
PP—SPRING, HOLDING, CAP

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Figure 119 — Distributor Assembly — Exploded View

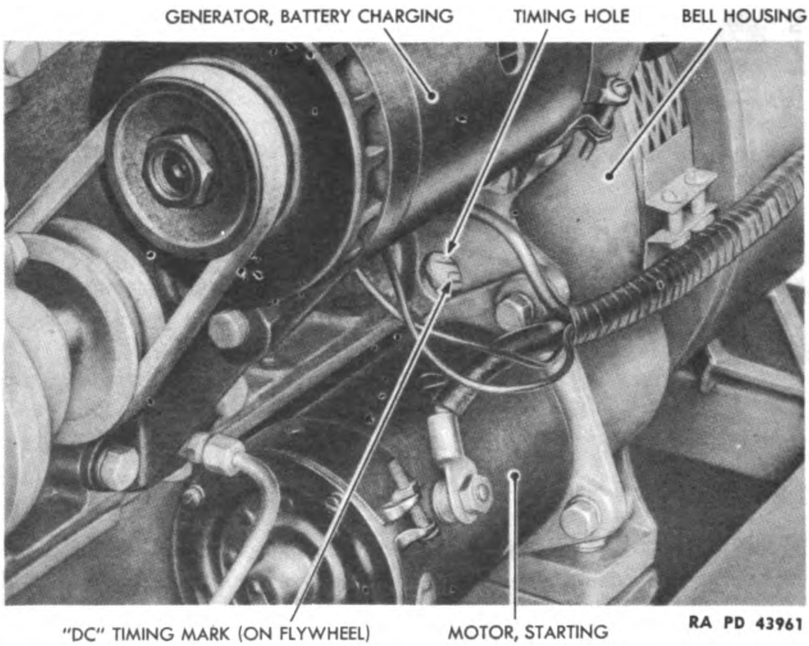

Figure 120 — Flywheel Timing Marks

(b) Place shaft and governor in base and, with a dial indicator, measure side play of shaft. Clamp indicator to base with point against shaft. Move shaft sideways and read indicator. If side play in any direction is over 0.005 inch, replace bushings (fig. 118). Drive bushings out of base and install new bushings (arbors).

(c) Place bushings on the arbor press and press into base, making lower bushing flush with base, and countersink upper bushing.

(7) Cam.

SOLVENT, dry-cleaning

Clean cam and upper weight plate in SOLVENT, dry-cleaning. Inspect cam and weight slots for evidence of wear. Replace cam if worn, or if slots do not have smooth, straight sides.

(8) Breaker Plate.

LAMP, test SOLVENT, dry-cleaning

Clean breaker plate in SOLVENT, dry-cleaning, and inspect for stripped threads. With test lamp, check terminal for grounds. Touch one probe to plate and the other probe to terminal. If lamp lights, terminal is grounded and plate must be replaced.

ENGINE ELECTRICAL SYSTEM: IGNITION

101. DISTRIBUTOR ASSEMBLY.

a. Equipment.

DRIVER, bushing
HAMMER
PLIERS, thin-nosed
PRESS, arbor
SCREWDRIVER
WRENCH, open-end, 1/4-in.
WRENCH, open-end, 3/8-in.

b. Procedure (fig. 119).

(1) Place distributor body (X) in arbor press, and press upper drive shaft bushing (U) into body (X), making sure oilhole in bushing alines with oilhole in body. Press lower drive shaft bushing (Z) into body (X) (arbor press and bushing driver) (fig. 119).

(2) Assemble distributor governor weight spacer (Q) to the distributor drive shaft (S) with countersunk portion to top (fig. 119).

(3) Assemble distributor governor weights (R) to lower weight plate (fig. 119).

(4) Assemble cam and upper weight plate assembly (P) to drive shaft (S), making sure pins in upper weight plate enter holes in governor weights (R) and elongated holes in lower weight plate (fig. 119).

(5) Assemble the two governor weight springs (L) to plate and to pins in weights (R) (thin-nosed pliers) (fig. 119).

(6) Assemble cam and upper weight plate retaining spring (N) (hairpin type) to secure cam to drive shaft (S) (thin-nosed pliers) (fig. 119).

(7) Assemble distributor drive shaft thrust washer (T) to lower end of distributor drive shaft (S) (fig. 119).

(8) Assemble distributor drive gear thrust washer (BB) onto distributor drive shaft (fig. 119).

(9) Assemble distributor drive shaft (S), cam, and weight assembly (P) to distributor body (X) (fig. 119).

(10) Assemble distributor drive shaft gear (CC) to shaft (S), alining pinhole in gear (CC) with pinhole in shaft (S). Drive distributor drive pin (DD) in place and peen over both ends (hammer) (fig. 119).

(11) Install breaker screw of breaker point set (C) to circuit breaker plate (K) (1/4-in. open-end wrench) (fig. 119).

(12) Assemble circuit breaker plate (K) to distributor body (X). Assemble cap-holding spring (PP), screws (V and MM), and plain washers (W and NN) to body and circuit breaker plate (screwdriver) (fig. 119).

(13) Assemble circuit breaker terminal stop washer (E), insulating bushing (H), and terminal washer (G) (small) to circuit breaker terminal (D) (fig. 119).

(14) Install terminal assembly in distributor body (X), and assemble terminal outside insulating washers (FF), shakeproof lock washer (JJ), condenser wire terminal, lock washer (KK), and nut (LL) to terminal. NOTE: Do not tighten nut (LL) (fig. 119).

(15) Assemble breaker arm of breaker point assembly (C) between square end of terminal (D) and square washer (E), and over pin in circuit breaker plate (K). Tighten terminal nut (LL) (3/8-in. open-end wrench) (fig. 119).

(16) Assemble condenser (EE) to distributor body (X) with screw (HH) and shakeproof lock washer (GG) (screwdriver) (fig. 119).

(17) With cam of breaker arm of breaker point set (C) on lobe of distributor cam, adjust breaker point gap to 0.018 inch. Install and tighten distributor point lock nut (J) (1/4-in. open-end wrench) (fig. 119).

(18) Assemble rotor (B) to distributor cam, and cap (A) to distributor body (X) (fig. 119).

102. DISTRIBUTOR TESTS AND ADJUSTMENTS.

a. Equipment.

FIXTURE, distributor test SCREWDRIVER

b. Procedure.

(1) Place distributor on a distributor test fixture, and set controls to measure cam angle or dwell. Operate distributor up and down the speed range, and note fluctuations in meter. Excessive fluctuation is caused by a worn cam or sticking contact pivot. Adjust reading to 41 degrees by changing contact point gap (screwdriver). Tighten lock nut after each adjustment. (This operation can be done on the unit only if the Ignition Circuit Tester M1 is available.)

(2) Adjust centrifugal advance. This operation can be done only on a fixture that will show the firing point in degrees and distributor speed in revolutions per minute.

(a) Run distributor at 250 distributor revolutions per minute and set dial at zero degrees.

(b) Increase speed up to 1,200 revolutions per minute and note advance. Specifications are 12 distributor degrees. If maximum advance is not within specifications, reduce speed below 250 revolutions per minute and note whether or not degree indicator drops below zero. If an indication below zero is shown, stop distributor. Bend out slightly outer spring bracket (fig. 119) (to which the weak weight spring is hooked), and again check at 1,200 revolutions per minute. If advance is still not 12 degrees, stop distributor and relieve the strong spring tension slightly by bending outer spring

bracket. Advance specifications at distributor revolutions per minute as follows:

Degrees:	0	2	9	11	12
Revolutions per minute:	250	310	500	970	1,200

103. DISTRIBUTOR INSTALLATION AND TIMING.

a. Equipment.

SCREWDRIVER
WRENCH, open-end, 3/8-in.
WRENCH, open-end, 11/16-in.
WRENCH, spark plug, 13/16-in.

b. Procedure.

(1) Remove spark plug (13/16-in. spark plug wrench) from No. 1 cylinder, and, with finger over spark plug hole, crank engine with hand crank until compression is felt.

(2) Continue cranking engine (very slowly) until the spark mark on the front face of the flywheel lines up with the mark on the bell housing casting across the center of the timing hole. Measured in inches on the flywheel, this mark is roughly 1 to 1 3/8 inches ahead of the "DC" mark. NOTE: Timing hole is located on the left or accessory drive side of the engine, just above the starting motor (fig. 120).

(3) Place distributor cap in position on distributor, and mark on distributor body the location of the No. 1 spark plug wire in distributor cap. Remove distributor cap.

(4) Position distributor spacer on top of accessory drive housing (fig. 121).

(5) Start gear end of distributor through its hole in accessory drive housing, with the oiler pointing toward the engine breather pipe, and the distributor rotor pointing toward the location mark made in step (4) above. Push distributor in position, allowing the distributor drive shaft gear to mesh with accessory drive gear, until distributor body rests on distributor spacer (fig. 121).

(6) Slightly rotate distributor base until breaker points are just beginning to open, when the rotor is moved to a clockwise direction. Lock distributor in this position with setscrew and lock nut (screwdriver and 11/16-in. open-end wrench). NOTE: Rotor can be sufficiently moved without cranking engine. After distributor is locked in position, the rotor must point toward location mark made on its base.

(7) Install spark plug (13/16-in. spark plug wrench) and distributor cap, and connect ignition coil wire (3/8-in. open-end wrench). NOTE: Engine firing order is 1-2-4-3. Spark plug wires removed from distributor cap should be replaced in this order, following around distributor cap in clockwise direction, with No. 1 spark plug

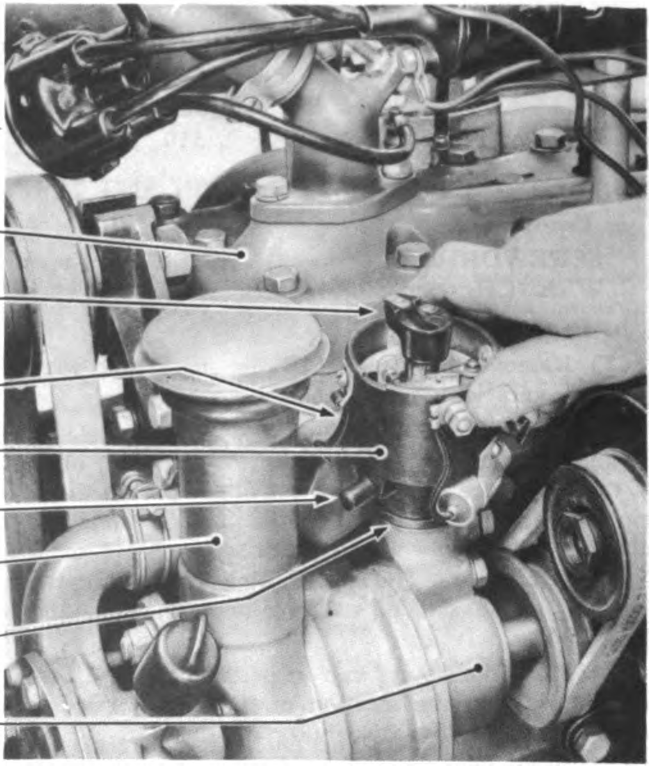

Figure 121 — Timing Distributor

wire in line with distributor rotor while No. 1 cylinder is in firing position.

104. SPARK PLUGS.

a. Removal (fig. 122).

WRENCH, spark plug, $1\frac{3}{16}$-in.

(1) Pull spark plug wires from spark plugs (fig. 122).

(2) Remove spark plugs from cylinder head ($1\frac{3}{16}$-in. spark plug wrench).

b. Inspection and Repair.

CLEANER, sand blast spark plug
GAGE, feeler
TESTER, spark plug
TOOL, spark plug adjusting

(1) TYPE OF SPARK PLUG. Examine the manufacturer's symbols on spark plug porcelain. Replace spark plug with proper type if wrong type is in use. Proper type is Titan No. 6, or its equivalent.

ENGINE ELECTRICAL SYSTEM: IGNITION

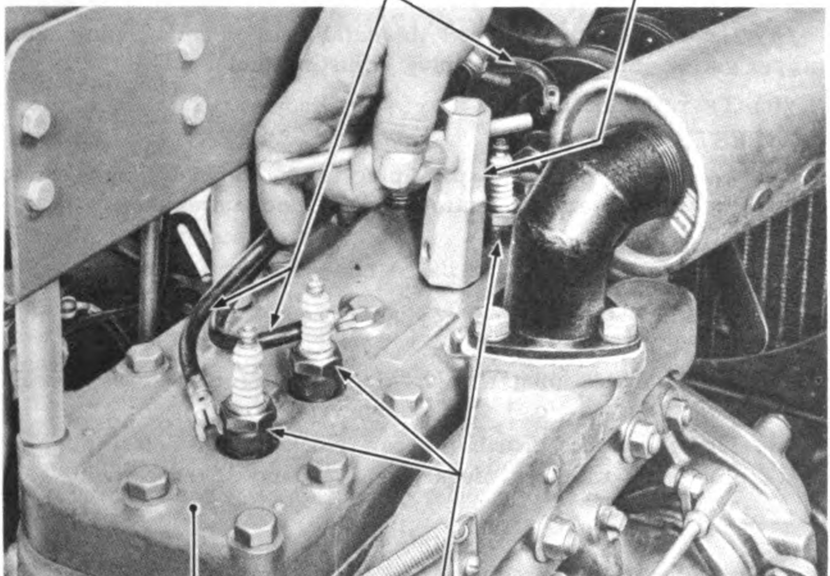

Figure 122 — Removing Spark Plug

(2) INSPECT ELECTRODES. Examine the electrodes. Replace spark plug if electrodes are burned.

(3) INSPECT PORCELAIN.

(a) Examine the porcelain. Replace spark plug if porcelain is cracked or broken.

(b) Note the color of the porcelain at the center electrode tip.

1. A light brown color indicates that the plug is operating correctly.

2. A glossy, black deposit indicates an excessive amount of oil in the combustion chamber. Check piston rings and pistons. Correct the fault.

3. A dull, black deposit indicates a rich fuel mixture, weak ignition, improper spark plug gaps, or weak compression. Locate and correct the cause.

(4) CLEAN SPARK PLUGS.

CLEANER, sand blast spark plug

(a) Clean each spark plug in a sand blast spark plug cleaner, or its equivalent.

(5) SET SPARK PLUG GAPS.

GAGE, feeler | TOOL, spark plug adjusting

(a) Measure gap between electrodes of each spark plug (feeler gage). Proper clearance is 0.025 inch.

(b) Bend electrode attached to metal base of spark plug until proper gap is obtained (spark plug adjusting tool).

(6) TEST SPARK PLUGS.

TESTER, spark plug

Test each spark plug in a spark plug tester. Replace plug if spark fails to flow freely across electrodes while under pressure.

c. Installation.

WRENCH, spark plug, $^{13}/_{16}$-in.

(1) Install spark plugs in cylinder head ($^{13}/_{16}$-in. spark plug wrench) (fig. 122).

(2) Attach spark plug wire from distributor cap tower nearest No. 1 spark plug, to No. 1 spark plug.

(3) Going around distributor cap clockwise, attach remaining spark plug wires to spark plugs Nos. 2, 4, and 3, respectively.

Section XIII

ENGINE ELECTRICAL SYSTEM: STARTING MOTOR AND BATTERY

Paragraph

105. DESCRIPTION AND CONSTRUCTION.

a. General. The starting system consists of a battery, starter switch, and starting motor, connected with heavy cables.

b. Starting System Construction.

(1) The starting motor is of the four brush type with Bendix drive. It is mounted on the flywheel housing at the lower left-hand side of the engine. The motor consists of a frame and field assembly, armature, and end plates. The four pole pieces and the four field coils are mounted in the frame. The field coils are connected in series. One lead of the coils is connected to an insulated terminal post, which passes through the frame. The other lead is connected to the brushes, which are held in brush holders in the commutator end plate. The commutator end plate is held to the frame by four screws and lock washers, and carries the four brush holders and springs. The armature shaft is mounted on bronze bearings in the commutator end plate and in the drive end head.

(2) The Bendix drive is mounted on the drive end of the armature. It gears the starting motor to the engine when the starter switch is closed, and releases it when the engine is started. It consists of a gear mounted on a hollow spiral shaft connected by splines to the armature shaft.

(3) The battery is a 6-volt, 120-ampere-hour battery. It is connected to the unit on the negative side by a battery ground strap. The positive post is connected to the starter switch by a cable.

(4) The starter switch is a manual type, mounted on the instrument panel. It has a set of contacts that are closed when the switch is depressed, and opened by a spring when released.

c. Operation of Starting System. When the starting switch is depressed, current from the battery flows to the starting motor terminal,

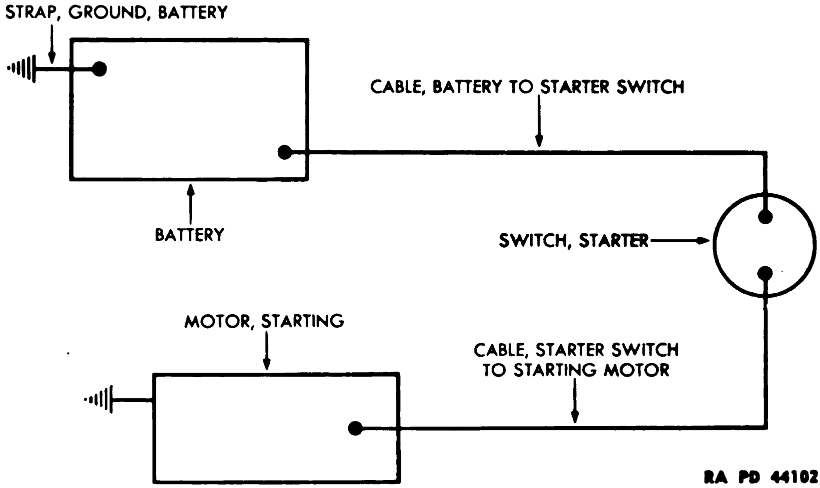

Figure 123 — Starting Motor Circuit

through the field coils to the insulated brushes, then through the armature coils and back through the commutator to the grounded brushes. The current in the field coils sets up a magnetic field, and the current in the armature coils sets up an opposing magnetic field. It is the force of these opposing fields which causes the armature to turn and produce the cranking torque. When the armature revolves, it turns a sleeve within the Bendix pinion and forces the gear forward, meshing it with the flywheel gear. The sudden shock of meshing is absorbed by the spring. When the engine starts, the pinion is driven faster than the sleeve, and is forced back along the threads, which automatically disengages the pinion from the flywheel.

106. SPECIFICATIONS.

a. Starting Motor.

Make . . . . Auto-Lite
Model MZ-4063
Rotation . . . . Clockwise, viewed from front

b. Bendix Drive.

Make . . . . Bendix-Eclipse
Model EBA-6
Rotation . . . . Clockwise, viewed from front

c. Battery.

Make . . . . Delco
Voltage . . . . 6 volts
Amperes . . . . 120 ampere-hours

d. Starting Switch.

Make . . . . Auto-Lite
Type 2-pole

ENGINE ELECTRICAL SYSTEM: STARTING MOTOR AND BATTERY

107. TROUBLE SHOOTING.

a. Starting Motor Fails to Operate.

Possible Cause	Possible Remedy
Battery discharged.	Recharge battery (par. 113).
Loose and dirty connections.	Clean and tighten connections.
Bendix gear jammed.	Free gear from flywheel.
Starting motor switch faulty.	Replace switch.
Bendix drive inoperative.	Remove starter and repair, or replace Bendix drive (pars. 108, 109, 110, and 111).

b. Starting Motor Cranks Weakly.

Battery weak.	Recharge battery (par. 113).
Loose or dirty connections.	Clean and tighten connections.
Commutator dirty.	Clean commutator with PAPER, flint, class B, No. 00 (par. 110).
Starting motor inoperative.	Remove, repair or replace starting motor (pars. 108, 109, 110, and 111).

c. Bendix Drive Fails to Operate When Starting Motor Revolves.

Dirty or gummy Bendix drive.	Remove starting motor (par. 108). Clean drive.
Drive spring broken.	Remove starting motor and replace drive spring (pars. 108, 109, 110, and 111).
Motor runs in wrong direction.	Change field leads to brushes or rotate brush assembly 90 degrees.

108. STARTING MOTOR REMOVAL (fig. 124).

a. Equipment.

WRENCH, open-end, $\frac{9}{16}$-in.

b. Procedure.

(1) Remove starting motor terminal nut ($\frac{9}{16}$-in. open-end wrench). Lift off starter switch to starting motor cable.

(2) Remove the three starting motor mounting cap screws and lock washers ($\frac{9}{16}$-in. open-end wrench).

(3) Lift starting motor from bell housing.

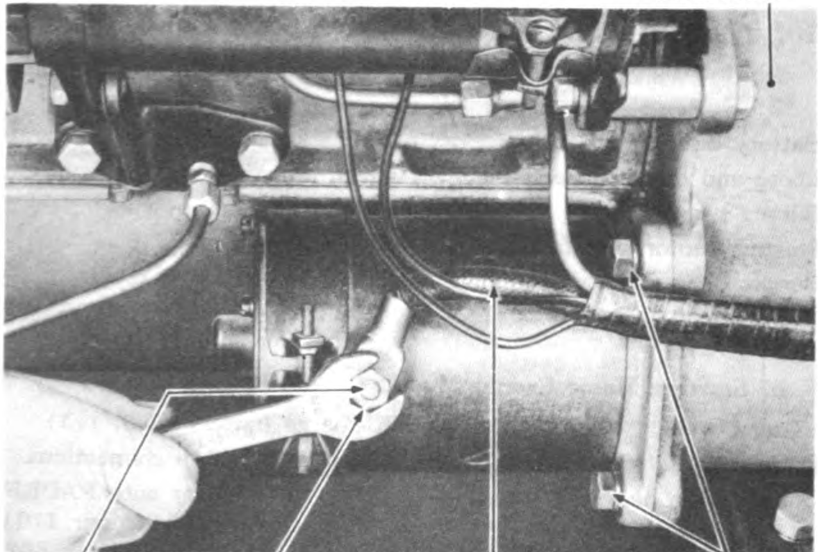

Figure 124 — Removing Starting Motor

109. STARTING MOTOR DISASSEMBLY (fig. 131).

a. Equipment.

CHISEL	SCREWDRIVER
DRIVER, bushing	SCREWDRIVER, heavy-duty
HAMMER	VISE
PLIERS	WRENCH, open-end, $^{9}/_{16}$-in.
PRESS, arbor	WRENCH, open-end, $^{25}/_{32}$-in.
PULLER	

b. Procedure.

(1) Remove starting motor commutator cover band screw nut (A) and screw (C), from cover band (B) (screwdriver). Remove cover band (B) from starting motor frame (fig. 131).

(2) Remove field coil brushes (R) from brush holders (H) by lifting brush holder spring (M) from end of brushes (fig. 131).

(3) Remove screws (D) and lock washers (E) which hold commutator end plate assembly (G) to starting motor frame (N), and remove commutator end plate assembly (G) (screwdriver) (fig. 131). Mark commutator end plate before removing. If the commutator end plate is placed 90 degrees out, it will cause the motor to run in reverse.

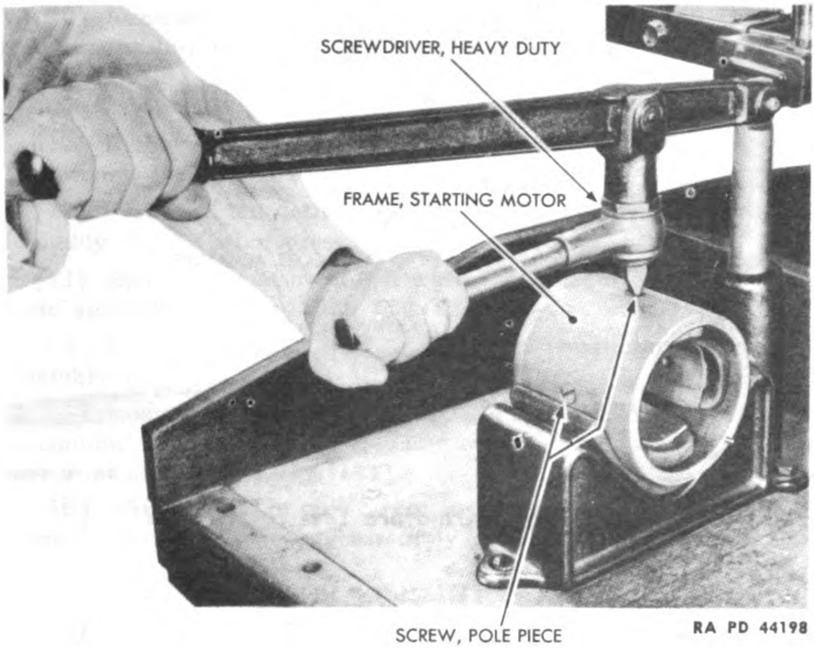

Figure 125 — Removing Pole Piece Screw

(4) Holding commutator end of armature (Y) in a vise, remove Bendix drive lock nut cotter pin (SS) from nut (TT) and armature shaft (pliers) (fig. 131).

(5) Remove Bendix drive lock nut (TT) from end of armature shaft ($^{25}/_{32}$-in. open-end wrench) (fig. 131).

(6) Remove Bendix drive lock nut collar (RR), drive lock nut washer (QQ), main spring (PP), spring support (NN), secondary spring (MM), secondary spring washer (LL), shaft (JJ), pinion (KK), retainer and spring assembly (HH), and hold-out spring cup (GG) from end of armature shaft (fig. 131).

(7) Remove screws (FF) and lock washers (EE) which hold drive end head (CC) to starting motor frame (N), and remove drive end head assembly (CC) (screwdriver) (fig. 131).

(8) Remove field coil terminal post nuts (UU), lock washers (VV), flat washer (WW), and terminal post insulation washer (XX) and bushing (YY) from terminal post (U) ($^{9}/_{16}$-in. open-end wrench) (fig. 131). Remove terminal post by hand.

(9) Mark position of field coils (T) in frame (N). Remove flat-head pole piece screws (P), and remove the pole pieces (X) (heavy-duty screwdriver) (figs. 125 and 131).

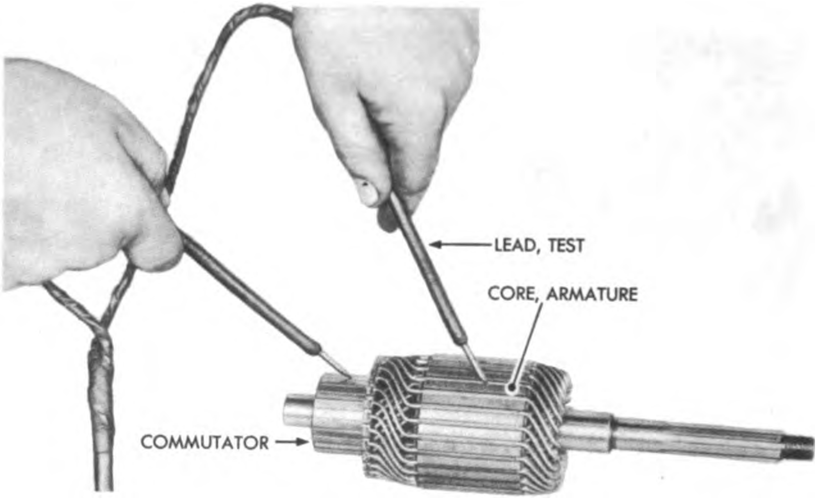

Figure 126 — Armature Test for Ground

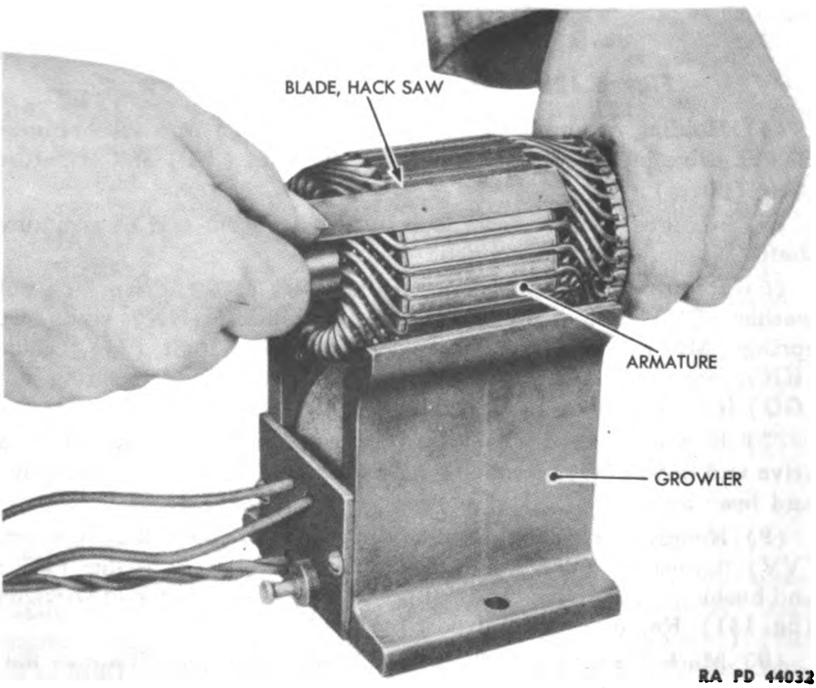

Figure 127 — Armature Test for Shorts

(10) Remove field coils (T). NOTE: Terminal stud field coil commutator terminals (S) and brushes (R) can be removed from field coils (T) if necessary by heating connections until solder is melted.

(11) Remove field coil terminal post insulation washer (Q) and insulation (W) (fig. 131).

(12) Press armature shaft bearing (DD) from drive end head assembly (CC) (arbor press and bushing driver) (fig. 131).

(13) Remove armature thrust washer (L) from commutator end plate assembly (G) by hand (fig. 131).

(14) Remove brush springs (M) from commutator end plate assembly (G) (fig. 131).

(15) Remove rivets (F) holding grounded brush holders (H) to commutator end plate (G), being careful not to damage holders (hammer and chisel) (fig. 131).

(16) With a suitable puller, remove commutator end bearing (J) from commutator end plate assembly (G) (fig. 131).

110. STARTING MOTOR INSPECTION AND REPAIR.

a. Equipment.

BLADE, hacksaw
COMPRESSED AIR
GROWLER
LAMP, test
LATHE
PAPER, flint, class B, No. 00
SOLDERING EQUIPMENT

b. Procedure.

(1) CLEAN COMMUTATOR.

COMPRESSED AIR PAPER, flint, class B, No. 00

(a) If the commutator is dirty or discolored, hold a piece of PAPER, flint, class B, No. 00, against commutator while turning armature slowly. Blow sand off commutator after sanding (compressed air).

(2) REPAIR OF ROUGH OR WORN COMMUTATOR.

LATHE

If commutator is rough or worn, place armature in lathe. Take as light a cut as possible to remove roughness and true-up commutator. Do not undercut mica between commutator bars.

(3) TEST ARMATURE FOR GROUNDS.

LAMP, test

Hold one test prod lead on the armature, and the other on the commutator (fig. 126). If test lamp lights, armature is grounded and must be replaced. If test lamp does not light, armature is not

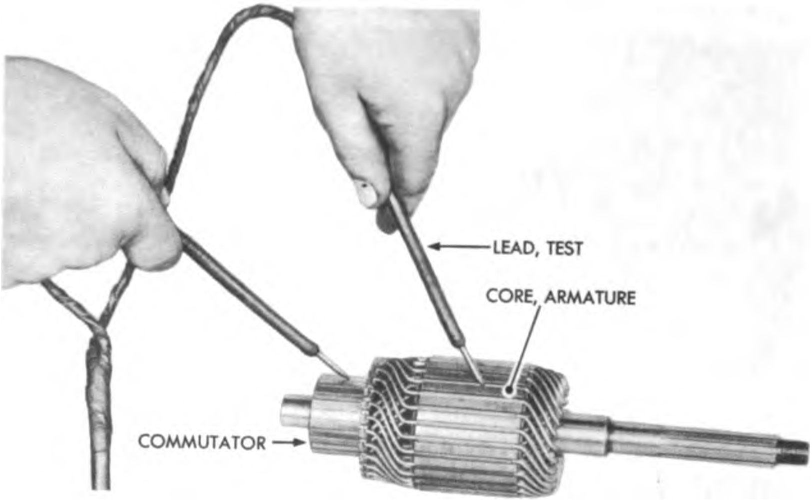

Figure 126 — Armature Test for Ground

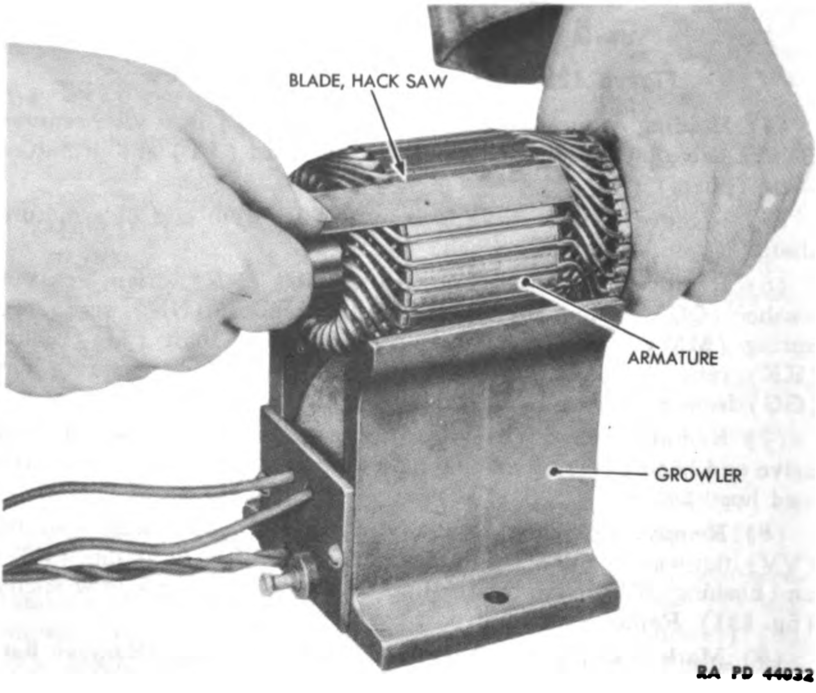

Figure 127 — Armature Test for Shorts

(10) Remove field coils (T). NOTE: Terminal stud field coil commutator terminals (S) and brushes (R) can be removed from field coils (T) if necessary by heating connections until solder is melted.

(11) Remove field coil terminal post insulation washer (Q) and insulation (W) (fig. 131).

(12) Press armature shaft bearing (DD) from drive end head assembly (CC) (arbor press and bushing driver) (fig. 131).

(13) Remove armature thrust washer (L) from commutator end plate assembly (G) by hand (fig. 131).

(14) Remove brush springs (M) from commutator end plate assembly (G) (fig. 131).

(15) Remove rivets (F) holding grounded brush holders (H) to commutator end plate (G), being careful not to damage holders (hammer and chisel) (fig. 131).

(16) With a suitable puller, remove commutator end bearing (J) from commutator end plate assembly (G) (fig. 131).

110. STARTING MOTOR INSPECTION AND REPAIR.

a. Equipment.

BLADE, hacksaw
COMPRESSED AIR
GROWLER
LAMP, test
LATHE
PAPER, flint, class B, No. 00
SOLDERING EQUIPMENT

b. Procedure.

(1) CLEAN COMMUTATOR.

COMPRESSED AIR
PAPER, flint, class B, No. 00

(a) If the commutator is dirty or discolored, hold a piece of PAPER, flint, class B, No. 00, against commutator while turning armature slowly. Blow sand off commutator after sanding (compressed air).

(2) REPAIR OF ROUGH OR WORN COMMUTATOR.

LATHE

If commutator is rough or worn, place armature in lathe. Take as light a cut as possible to remove roughness and true-up commutator. Do not undercut mica between commutator bars.

(3) TEST ARMATURE FOR GROUNDS.

LAMP, test

Hold one test prod lead on the armature, and the other on the commutator (fig. 126). If test lamp lights, armature is grounded and must be replaced. If test lamp does not light, armature is not

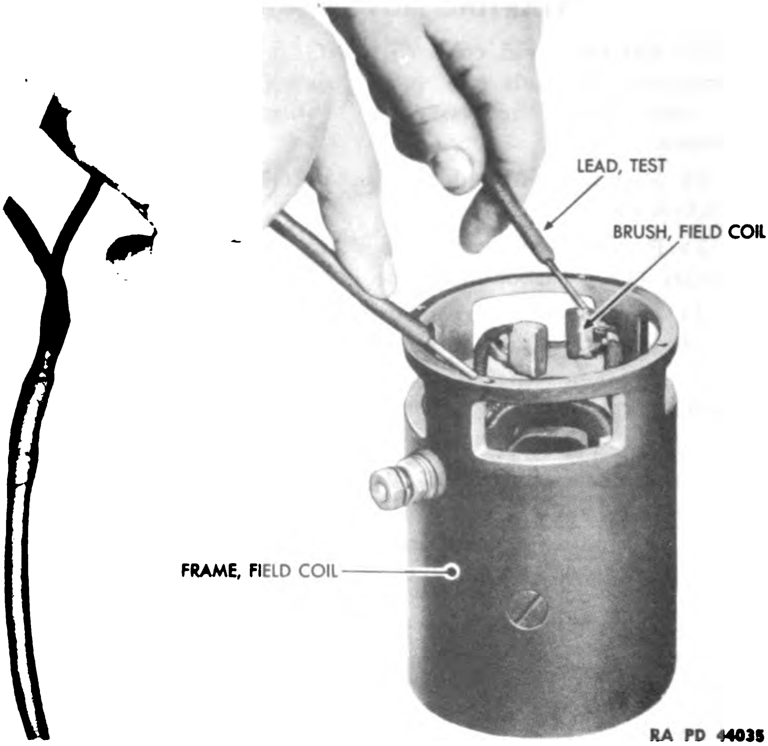

Figure 128 — Field Coil Test for Ground

grounded. NOTE: Test each commutator segment with test prod lead.

(4) TEST ARMATURE FOR SHORTS.

BLADE, hacksaw GROWLER

Place armature on a growler. Hold a hacksaw blade over armature core. Rotate armature slowly by hand (fig. 127). If hacksaw blade does not vibrate, armature is not short-circuited. If hacksaw blade vibrates, armature is short-circuited and must be replaced.

(5) TEST FRAME AND FIELD COIL FOR GROUND.

LAMP, test

Place one test prod lead on frame, and the other on the field coil lead (fig. 128). If test lamp does not light, field coils are not grounded. If test lamp lights, one or both field coils are grounded. Replace field coils if grounded.

(6) TEST FIELD COIL FOR CONTINUOUS CIRCUIT.

LAMP, test

Place test prod leads on field coil leads (fig. 129). If test lamp lights, field coils have no open circuit. If test lamp does not light,

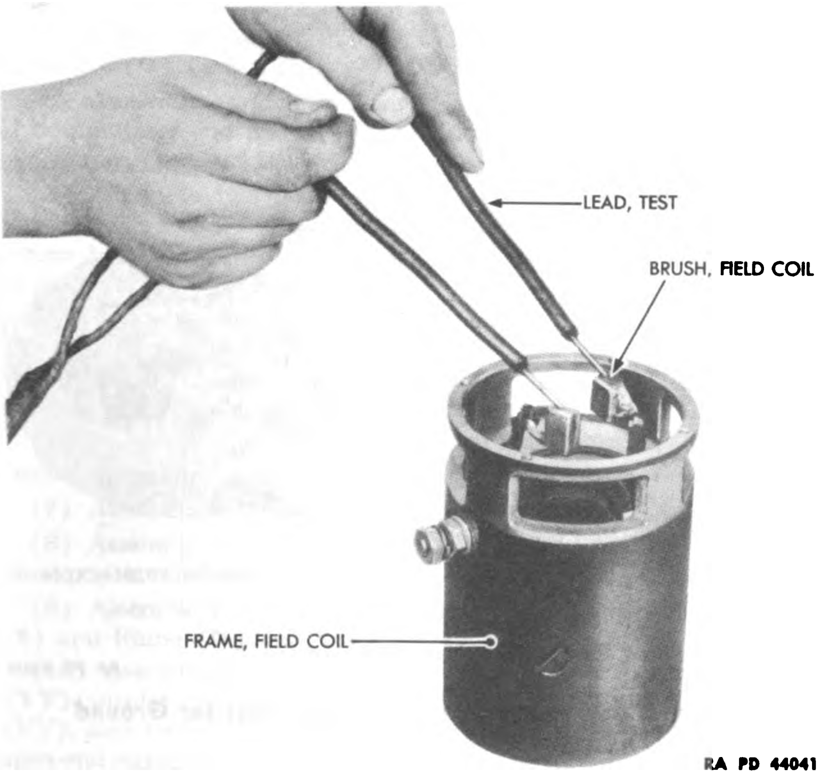

Figure 129 — Field Coil Test for Continuous Circuit

there is an open circuit in one or both of the field coils. Replace field coils.

(7) TEST INSULATED BRUSH HOLDER FOR GROUND.

LAMP, test

Place on test prod lead on commutator end plate, and the other on the brush holder (fig. 130). If test lamp lights, brush holder is grounded, and insulation between brush holder and plate, as well as between the two rivets and plate, must be replaced.

(8) INSPECT FIELD COIL LEADS.

Inspect field coil leads where they are soldered to connections, to be sure they are tight.

(9) INSPECT BRUSHES.

Check condition of all brushes, and if pitted or worn, replace them.

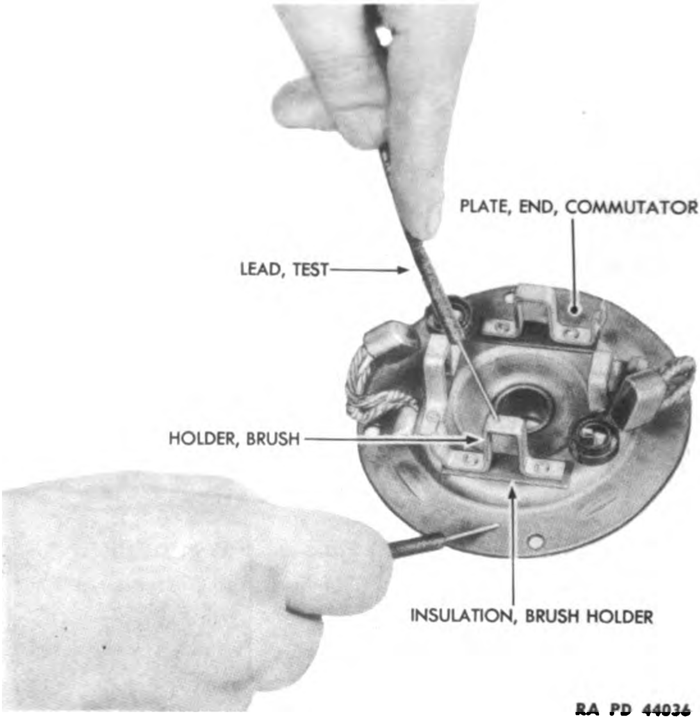

Figure 130 — Insulated Brush Holder Test for Ground

(10) Check Tension of the Brush Holder Springs.
Brush holder springs must have enough tension to hold brushes snugly against commutator. Replace weak or broken springs.

(11) Inspect Brush Leads.
SOLDERING EQUIPMENT
Check soldered connections of the two grounded brushes on commutator end frame to be sure they are tight. If loose, resolder (soldering equipment). Check insulation of brush to field coil leads. If insulation is damaged, replace leads.

111. STARTING MOTOR ASSEMBLY.

a. Equipment.

DRIVER, bushing
HAMMER
PRESS, arbor
RIVET SET
SCREWDRIVER
SCREWDRIVER, heavy-duty
VISE
WRENCH, open-end, $\frac{9}{16}$-in.
WRENCH, open-end, $\frac{25}{32}$-in.

ENGINE ELECTRICAL SYSTEM: STARTING MOTOR AND BATTERY

b. Procedure. (fig. 131).

(1) Press commutator bearing (J) in the commutator end plate assembly (G) (arbor press and bushing driver) (fig. 131).

(2) Assemble grounded brushes (K) and two brush holders (H) to commutator end plate (G), and securely rivet in place (rivet set and hammer) (fig. 131).

(3) Assemble two brush holders (H), with insulation between brush holders and end plate. Place insulation over rivets (F), and secure brush holders (H) and insulation to plate (G) by peening rivets securely (hammer) (fig. 131).

(4) Assemble four brush holder springs (M) to the four brush holders (fig. 131).

(5) Place armature thrust washer (L) in position in end plate assembly (G) by hand (fig. 131).

(6) Press armature shaft bearing (DD) in drive end head (CC) (arbor press and bushing driver) (fig. 131).

(7) Assemble field coil insulation (W) to frame (fig. 131).

(8) Assemble field coils (T) and pole pieces (X) to frame (N) in same position as before removal (heavy-duty screwdriver) (fig. 131).

(9) Assemble terminal washer (Q) between field coil connection (S) and frame (N) (fig. 131).

(10) Assemble terminal post (U) to frame (N). Assemble bushing (YY), insulation washer (XX), flat washer (WW), lock washers (VV), and terminal post nuts (UU) to terminal post (U) ($\frac{9}{16}$-in. open-end wrench) (fig. 131).

(11) Assemble drive end head assembly (CC) to frame (N), securing in place with four screws (FF) and lock washers (EE) (screwdriver) (fig. 131).

(12) Assemble armature (Y) to frame (N) and drive end head assembly (CC) (fig. 131).

(13) Securely hold armature (Y) (commutator end) in vise, and assemble Bendix-hold-out spring cup (GG), retainer and spring assembly (HH), pinion (KK), shaft (JJ), washer (LL), secondary spring (MM), secondary spring support (NN), main spring (PP), washer (QQ), drive lock nut collar (RR) and drive lock nut (TT), and cotter pin (SS) to end of armature shaft ($\frac{25}{32}$-in. open-end wrench) (fig. 131).

(14) Assemble commutator end plate assembly (G) over end of armature (Y), holding grounded brushes (K) away from commutator, and secure in place with screws (D) and lock washers (E) (screwdriver) (fig. 131).

(15) Assemble field coil brushes (R) to brush holders (H), and place brush holder springs (M) in position (fig. 131).

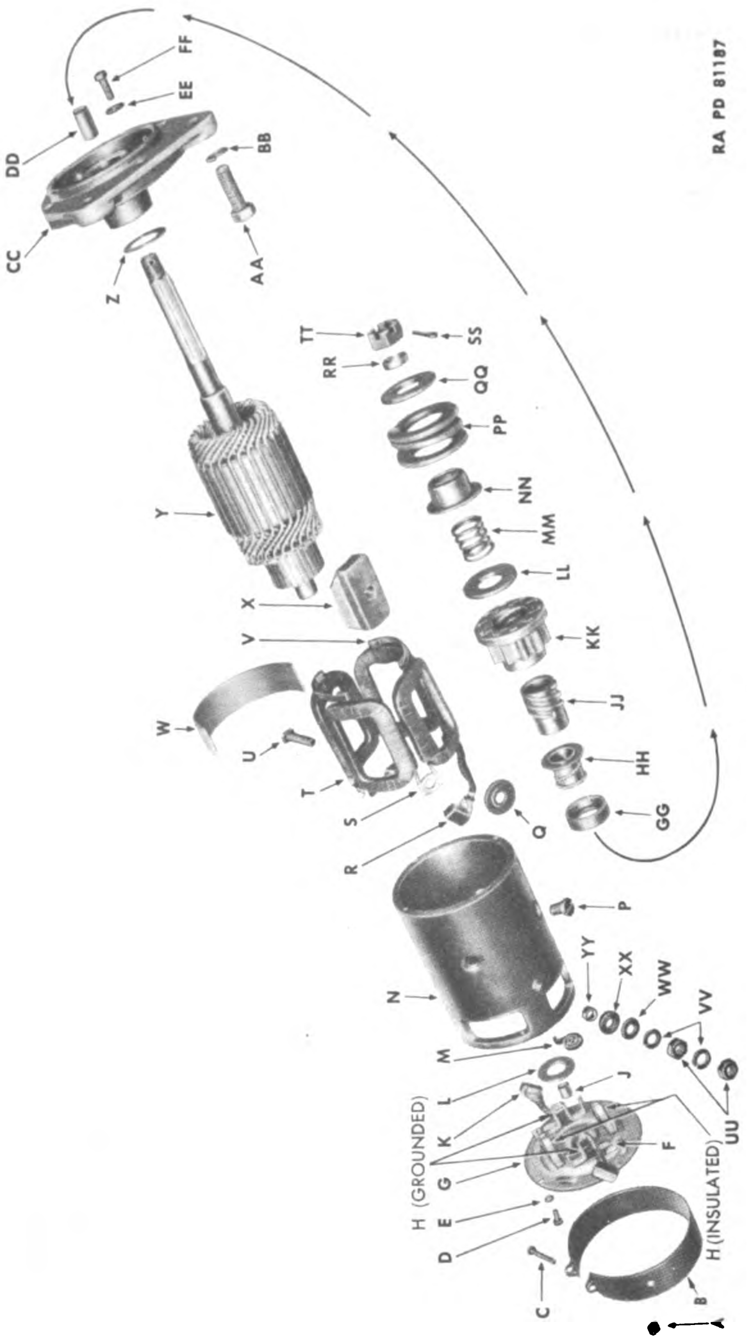

Figure 131 — Starting Motor Assembly — Exploded View

ENGINE ELECTRICAL SYSTEM: STARTING MOTOR AND BATTERY

A — NUT, COVER BAND SCREW
B — BAND, COVER
C — SCREW, COVER BAND
D — SCREW, COMMUTATOR END FRAME
E — WASHER, LOCK
F — RIVET, BRUSH HOLDER
G — PLATE, COMMUTATOR END, ASSEMBLY
H — HOLDER, BRUSH
J — BEARING, COMMUTATOR END
K — BRUSH, GROUNDED
L — WASHER, ARMATURE THRUST (COMMUTATOR END)
M — SPRING, BRUSH HOLDER
N — FRAME
P — SCREW, POLE PIECE
Q — WASHER, FIELD COIL TERMINAL POST INSULATION
R — BRUSH, FIELD COIL
C — CONNECTION, FIELD COIL
T — COIL, FIELD
U — POST, TERMINAL
V — CONNECTOR, FIELD COIL
W — INSULATION, FIELD COIL
X — PIECE, POLE
Y — ARMATURE
Z — WASHER, THRUST, ARMATURE (DRIVE END)
AA — SCREW, CAP, GENERATOR MOUNTING
BB — WASHER, LOCK, GENERATOR MOUNTING CAP SCREW
CC — HEAD, DRIVE END
DD — BEARING, ARMATURE SHAFT
EE — WASHER, LOCK
FF — SCREW
GG — CUP, BENDIX DRIVE HOLD-OUT SPRING
HH — RETAINER AND SPRING, ASSEMBLY
JJ — SHAFT
KK — PINION
LL — WASHER, SECONDARY SPRING
MM — SPRING, SECONDARY
NN — SUPPORT, SPRING
PP — SPRING, MAIN
QQ — WASHER, DRIVE LOCK NUT
RR — COLLAR, DRIVE LOCK NUT
SS — PIN, COTTER, BENDIX DRIVE LOCK NUT
TT — NUT, LOCK, BENDIX DRIVE
UU — NUT, TERMINAL POST
VV — WASHER, LOCK
WW — WASHER, FLAT
XX — WASHER, INSULATION
YY — BUSHING, TERMINAL POST

RA PD 81187A

Legend for Figure 131 — Starting Motor Assembly — Exploded View

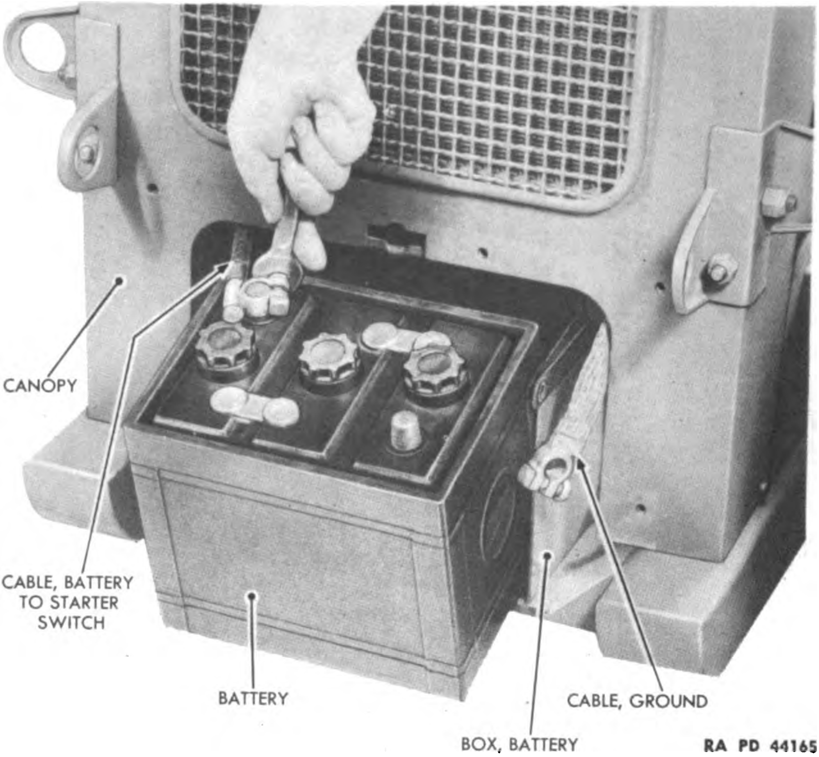

Figure 132 — Removing Battery

(16) Assemble commutator cover band (B) with screw (C), and nut (A) to starting motor (screwdriver) (fig. 131).

(17) Connect starting motor to a battery, and operate for running test to be sure all repairs have been satisfactorily made. If starting motor fails to operate, disassemble it; locate and repair trouble (steps (1) through (17) above).

112. STARTING MOTOR INSTALLATION.

a. Equipment.

WRENCH, open-end, $^9/_{16}$-in.

b. Procedure (fig. 124).

(1) Place starting motor in position on bell housing.

(2) Install the three starting motor mounting cap screws and lock washers ($^9/_{16}$-in. open-end wrench).

(3) Connect cable to starting motor terminal. Install starting motor terminal nut ($^9/_{16}$-in. open-end wrench).

113. BATTERY.

a. Equipment.

CHARGER, battery
HYDROMETER
SCREWDRIVER
TESTER, battery cell
VOLTMETER
WIRE brush
WRENCH, open-end, ½-in. (2)
WRENCH, open-end, 9⁄16-in.

b. Procedure.

(1) REMOVAL (fig. 132).

SCREWDRIVER
WRENCH, open-end, 9⁄16-in.
WRENCH, open-end, ½-in. (2)

(a) Remove battery cover from housing (screwdriver) (fig. 1).

(b) Remove battery clamp bolt which secures battery in battery box (two ½-in. open-end wrenches).

(c) Slide battery forward, and remove battery cables from battery (9⁄16-in. open-end wrench). NOTE: Remove ground (negative) cable first.

(2) INSPECTION AND REPAIR.

CHARGER, battery
TESTER, battery cell

(a) Recharge the battery (battery charger).

(b) Allow battery to stand for 24 hours after removal from battery charger.

(c) Test each cell of battery. If any cell is dead or weaker than the rest, replace or rebuild battery.

(3) TEST.

HYDROMETER
VOLTMETER
WIRE BRUSH

(a) Battery Capacity.

HYDROMETER
VOLTMETER

1. Take a specific gravity reading with a hydrometer. Reading should be 1.250 to 1.290 at 70 F. If reading is less than 1.250, charge battery on a battery charger.

2. Test voltage of battery with a voltmeter. It should register 6 volts. Recharge if less than 6 volts. Replace or rebuild battery if all cells do not have the same voltage.

(b) Battery Voltage Drop.

VOLTMETER
WIRE BRUSH

1. Connect a voltmeter positive lead to battery positive terminal. Connect voltmeter negative lead to battery negative terminal. Turn ignition switch off. Press starter switch and note voltmeter reading.

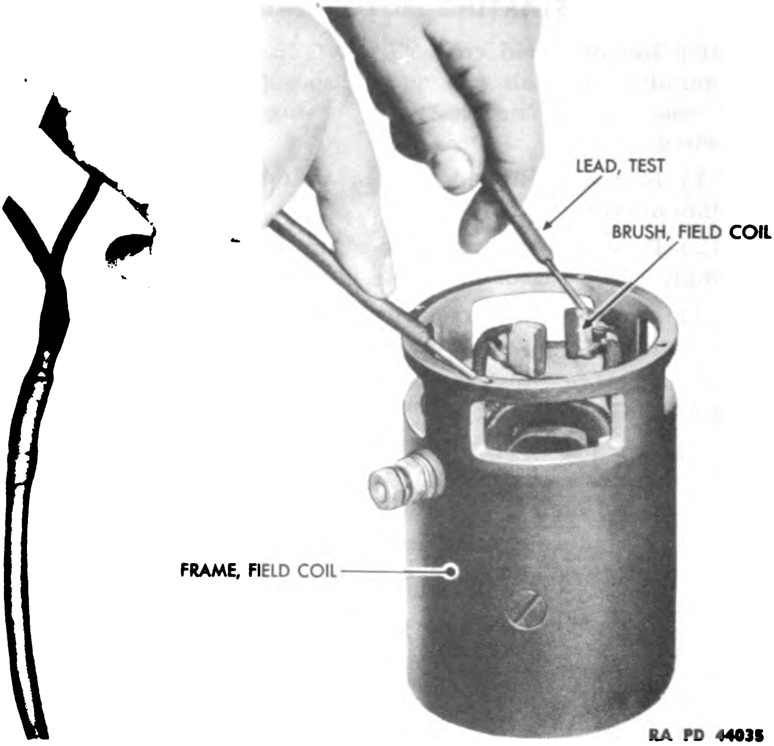

Figure 128 — Field Coil Test for Ground

grounded. NOTE: Test each commutator segment with test prod lead.

(4) TEST ARMATURE FOR SHORTS.

BLADE, hacksaw GROWLER

Place armature on a growler. Hold a hacksaw blade over armature core. Rotate armature slowly by hand (fig. 127). If hacksaw blade does not vibrate, armature is not short-circuited. If hacksaw blade vibrates, armature is short-circuited and must be replaced.

(5) TEST FRAME AND FIELD COIL FOR GROUND.

LAMP, test

Place one test prod lead on frame, and the other on the field coil lead (fig. 128). If test lamp does not light, field coils are not grounded. If test lamp lights, one or both field coils are grounded. Replace field coils if grounded.

(6) TEST FIELD COIL FOR CONTINUOUS CIRCUIT.

LAMP, test

Place test prod leads on field coil leads (fig. 129). If test lamp lights, field coils have no open circuit. If test lamp does not light,

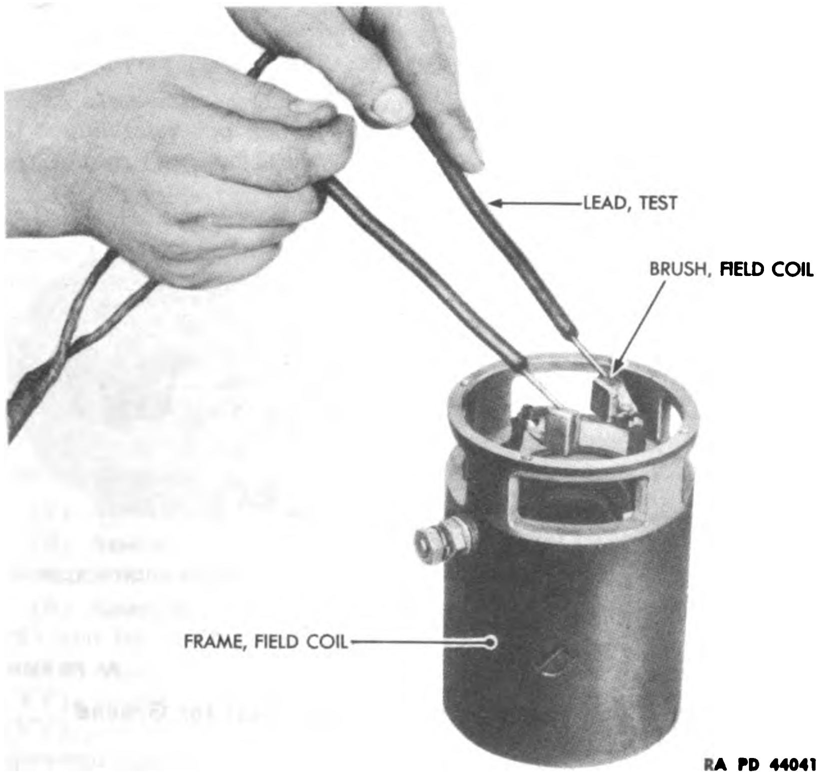

Figure 129 — Field Coil Test for Continuous Circuit

there is an open circuit in one or both of the field coils. Replace field coils.

(7) TEST INSULATED BRUSH HOLDER FOR GROUND.

LAMP, test

Place on test prod lead on commutator end plate, and the other on the brush holder (fig. 130). If test lamp lights, brush holder is grounded, and insulation between brush holder and plate, as well as between the two rivets and plate, must be replaced.

(8) INSPECT FIELD COIL LEADS.

Inspect field coil leads where they are soldered to connections, to be sure they are tight.

(9) INSPECT BRUSHES.

Check condition of all brushes, and if pitted or worn, replace them.

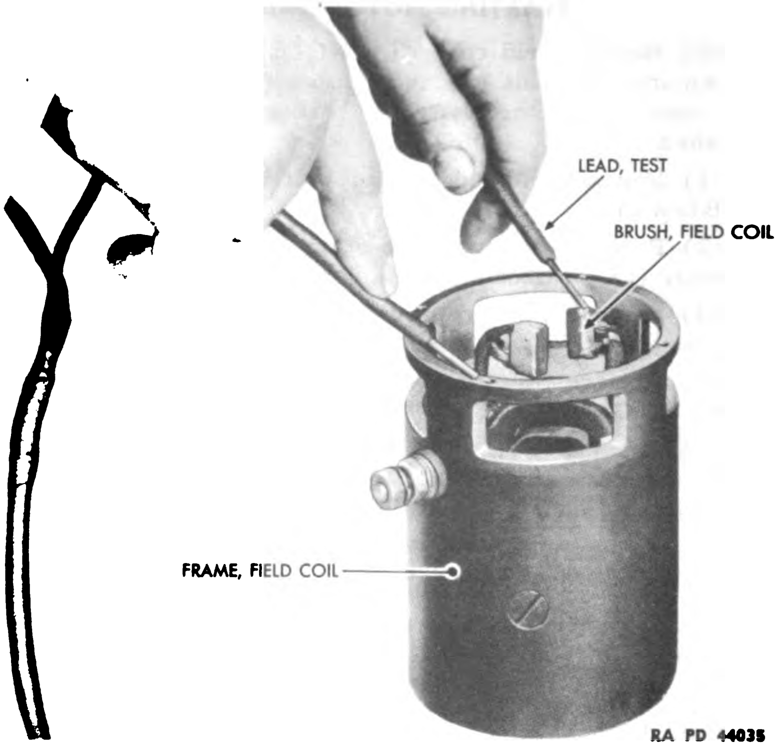

Figure 128 — Field Coil Test for Ground

grounded. NOTE: Test each commutator segment with test prod lead.

(4) Test Armature for Shorts.

BLADE, hacksaw GROWLER

Place armature on a growler. Hold a hacksaw blade over armature core. Rotate armature slowly by hand (fig. 127). If hacksaw blade does not vibrate, armature is not short-circuited. If hacksaw blade vibrates, armature is short-circuited and must be replaced.

(5) Test Frame and Field Coil for Ground.

LAMP, test

Place one test prod lead on frame, and the other on the field coil lead (fig. 128). If test lamp does not light, field coils are not grounded. If test lamp lights, one or both field coils are grounded. Replace field coils if grounded.

(6) Test Field Coil for Continuous Circuit.

LAMP, test

Place test prod leads on field coil leads (fig. 129). If test lamp lights, field coils have no open circuit. If test lamp does not light,

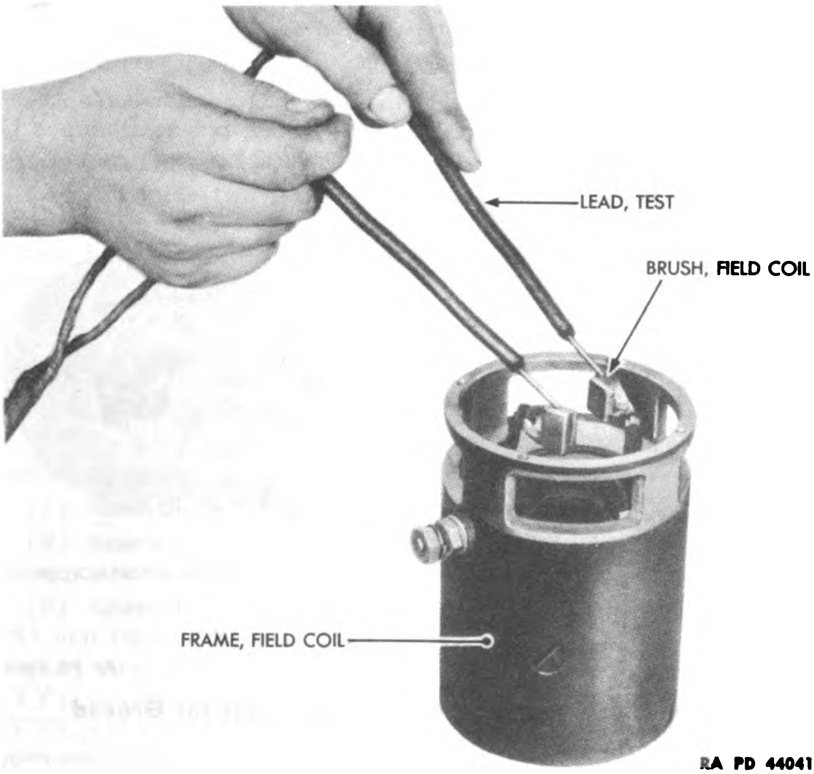

Figure 129 — Field Coil Test for Continuous Circuit

there is an open circuit in one or both of the field coils. Replace field coils.

(7) TEST INSULATED BRUSH HOLDER FOR GROUND.

LAMP, test

Place on test prod lead on commutator end plate, and the other on the brush holder (fig. 130). If test lamp lights, brush holder is grounded, and insulation between brush holder and plate, as well as between the two rivets and plate, must be replaced.

(8) INSPECT FIELD COIL LEADS.

Inspect field coil leads where they are soldered to connections, to be sure they are tight.

(9) INSPECT BRUSHES.

Check condition of all brushes, and if pitted or worn, replace them.

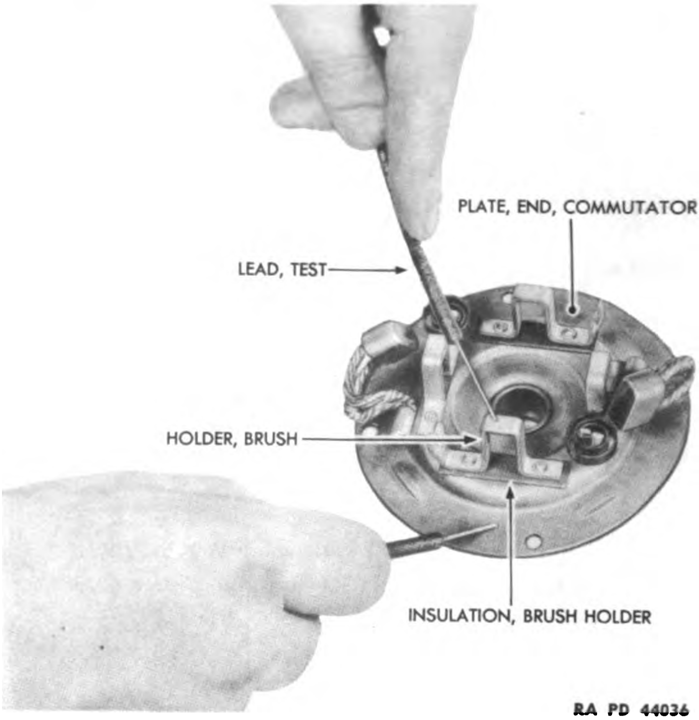

Figure 130 — Insulated Brush Holder Test for Ground

(10) CHECK TENSION OF THE BRUSH HOLDER SPRINGS. Brush holder springs must have enough tension to hold brushes snugly against commutator. Replace weak or broken springs.

(11) INSPECT BRUSH LEADS.

SOLDERING EQUIPMENT

Check soldered connections of the two grounded brushes on commutator end frame to be sure they are tight. If loose, resolder (soldering equipment). Check insulation of brush to field coil leads. If insulation is damaged, replace leads.

111. STARTING MOTOR ASSEMBLY.

a. Equipment.

DRIVER, bushing
HAMMER
PRESS, arbor
RIVET SET
SCREWDRIVER
SCREWDRIVER, heavy-duty
VISE
WRENCH, open-end, $^{9}/_{16}$-in.
WRENCH, open-end, $^{25}/_{32}$-in.

b. Procedure. (fig. 131).

(1) Press commutator bearing (J) in the commutator end plate assembly (G) (arbor press and bushing driver) (fig. 131).

(2) Assemble grounded brushes (K) and two brush holders (H) to commutator end plate (G), and securely rivet in place (rivet set and hammer) (fig. 131).

(3) Assemble two brush holders (H), with insulation between brush holders and end plate. Place insulation over rivets (F), and secure brush holders (H) and insulation to plate (G) by peening rivets securely (hammer) (fig. 131).

(4) Assemble four brush holder springs (M) to the four brush holders (fig. 131).

(5) Place armature thrust washer (L) in position in end plate assembly (G) by hand (fig. 131).

(6) Press armature shaft bearing (DD) in drive end head (CC) (arbor press and bushing driver) (fig. 131).

(7) Assemble field coil insulation (W) to frame (fig. 131).

(8) Assemble field coils (T) and pole pieces (X) to frame (N) in same position as before removal (heavy-duty screwdriver) (fig. 131).

(9) Assemble terminal washer (Q) between field coil connection (S) and frame (N) (fig. 131).

(10) Assemble terminal post (U) to frame (N). Assemble bushing (YY), insulation washer (XX), flat washer (WW), lock washers (VV), and terminal post nuts (UU) to terminal post (U) ($^9/_{16}$-in. open-end wrench) (fig. 131).

(11) Assemble drive end head assembly (CC) to frame (N), securing in place with four screws (FF) and lock washers (EE) (screwdriver) (fig. 131).

(12) Assemble armature (Y) to frame (N) and drive end head assembly (CC) (fig. 131).

(13) Securely hold armature (Y) (commutator end) in vise, and assemble Bendix-hold-out spring cup (GG), retainer and spring assembly (HH), pinion (KK), shaft (JJ), washer (LL), secondary spring (MM), secondary spring support (NN), main spring (PP), washer (QQ), drive lock nut collar (RR) and drive lock nut (TT), and cotter pin (SS) to end of armature shaft ($^{25}/_{32}$-in. open-end wrench) (fig. 131).

(14) Assemble commutator end plate assembly (G) over end of armature (Y), holding grounded brushes (K) away from commutator, and secure in place with screws (D) and lock washers (E) (screwdriver) (fig. 131).

(15) Assemble field coil brushes (R) to brush holders (H), and place brush holder springs (M) in position (fig. 131).

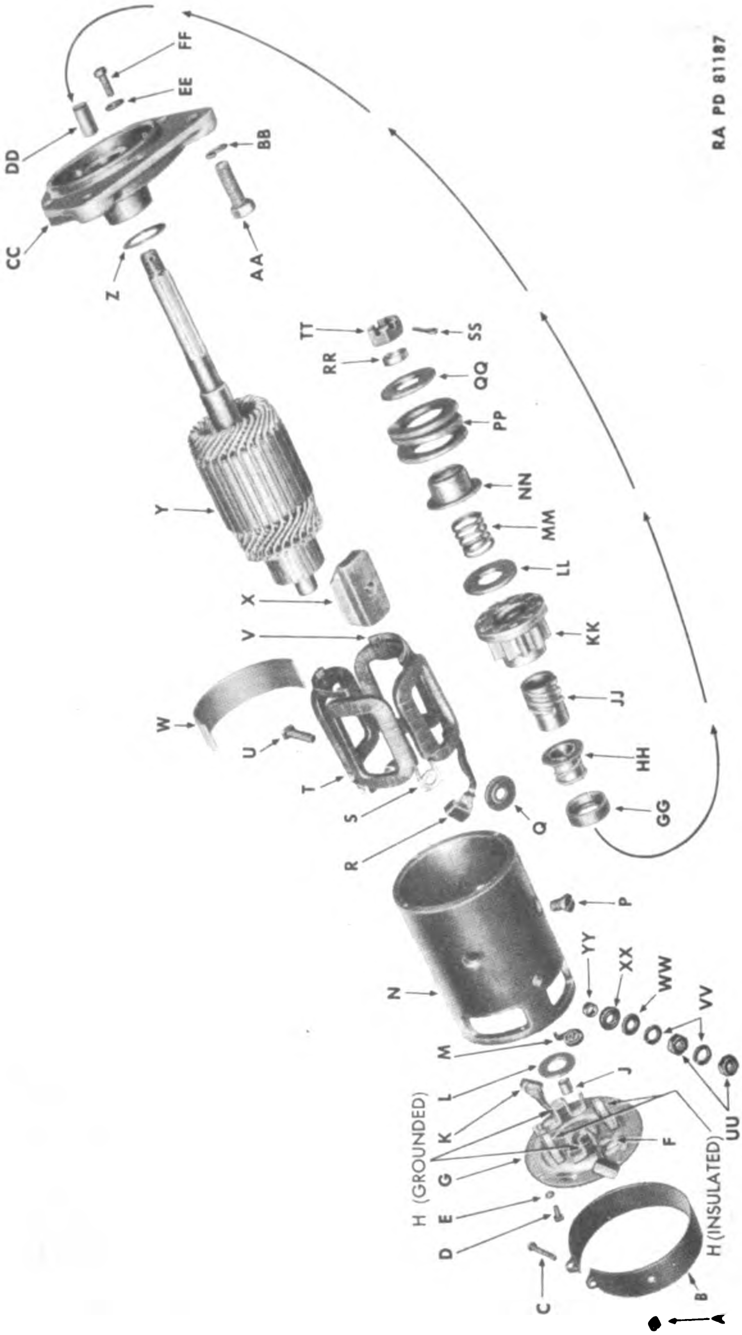

Figure 131 — Starting Motor Assembly — Exploded View

A — NUT, COVER BAND SCREW
B — BAND, COVER
C — SCREW, COVER BAND
D — SCREW, COMMUTATOR END FRAME
E — WASHER, LOCK
F — RIVET, BRUSH HOLDER
G — PLATE, COMMUTATOR END, ASSEMBLY
H — HOLDER, BRUSH
J — BEARING, COMMUTATOR END
K — BRUSH, GROUNDED
L — WASHER, ARMATURE THRUST (COMMUTATOR END)
M — SPRING, BRUSH HOLDER
N — FRAME
P — SCREW, POLE PIECE
Q — WASHER, FIELD COIL TERMINAL POST INSULATION
R — BRUSH, FIELD COIL
C — CONNECTION, FIELD COIL
T — COIL, FIELD
U — POST, TERMINAL
V — CONNECTOR, FIELD COIL
W — INSULATION, FIELD COIL
X — PIECE, POLE
Y — ARMATURE
Z — WASHER, THRUST, ARMATURE (DRIVE END)
AA — SCREW, CAP, GENERATOR MOUNTING
BB — WASHER, LOCK, GENERATOR MOUNTING CAP SCREW
CC — HEAD, DRIVE END
DD — BEARING, ARMATURE SHAFT
EE — WASHER, LOCK
FF — SCREW
GG — CUP, BENDIX DRIVE HOLD-OUT SPRING
HH — RETAINER AND SPRING, ASSEMBLY
JJ — SHAFT
KK — PINION
LL — WASHER, SECONDARY SPRING
MM — SPRING, SECONDARY
NN — SUPPORT, SPRING
PP — SPRING, MAIN
QQ — WASHER, DRIVE LOCK NUT
RR — COLLAR, DRIVE LOCK NUT
SS — PIN, COTTER, BENDIX DRIVE LOCK NUT
TT — NUT, LOCK, BENDIX DRIVE
UU — NUT, TERMINAL POST
VV — WASHER, LOCK
WW — WASHER, FLAT
XX — WASHER, INSULATION
YY — BUSHING, TERMINAL POST

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Legend for Figure 131 — Starting Motor Assembly — Exploded View

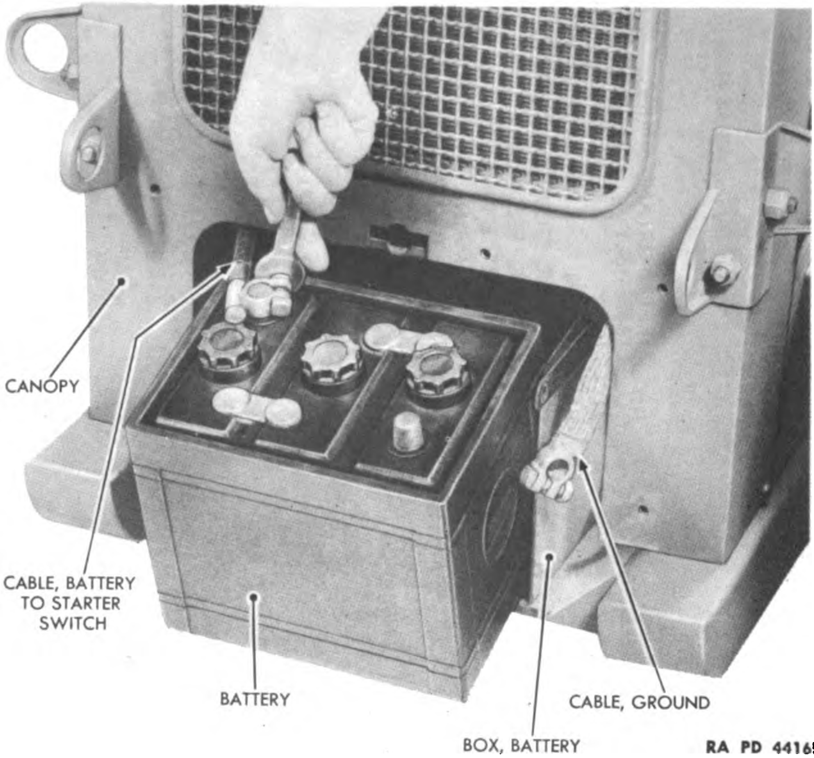

Figure 132 — Removing Battery

(16) Assemble commutator cover band (B) with screw (C), and nut (A) to starting motor (screwdriver) (fig. 131).

(17) Connect starting motor to a battery, and operate for running test to be sure all repairs have been satisfactorily made. If starting motor fails to operate, disassemble it; locate and repair trouble (steps (1) through (17) above).

112. STARTING MOTOR INSTALLATION.

a. Equipment.

WRENCH, open-end, $\frac{9}{16}$-in.

b. Procedure (fig. 124).

(1) Place starting motor in position on bell housing.

(2) Install the three starting motor mounting cap screws and lock washers ($\frac{9}{16}$-in. open-end wrench).

(3) Connect cable to starting motor terminal. Install starting motor terminal nut ($\frac{9}{16}$-in. open-end wrench).

ENGINE ELECTRICAL SYSTEM: STARTING MOTOR AND BATTERY

113. BATTERY.

a. Equipment.

CHARGER, battery
HYDROMETER
SCREWDRIVER
TESTER, battery cell
VOLTMETER
WIRE brush
WRENCH, open-end, ½-in. (2)
WRENCH, open-end, 9/16-in.

b. Procedure.

(1) REMOVAL (fig. 132).

SCREWDRIVER
WRENCH, open-end, 9/16-in.
WRENCH, open-end, ½-in. (2)

(a) Remove battery cover from housing (screwdriver) (fig. 1).

(b) Remove battery clamp bolt which secures battery in battery box (two ½-in. open-end wrenches).

(c) Slide battery forward, and remove battery cables from battery (9/16-in. open-end wrench). NOTE: Remove ground (negative) cable first.

(2) INSPECTION AND REPAIR.

CHARGER, battery
TESTER, battery cell

(a) Recharge the battery (battery charger).

(b) Allow battery to stand for 24 hours after removal from battery charger.

(c) Test each cell of battery. If any cell is dead or weaker than the rest, replace or rebuild battery.

(3) TEST.

HYDROMETER
VOLTMETER
WIRE BRUSH

(a) Battery Capacity.

HYDROMETER
VOLTMETER

1. Take a specific gravity reading with a hydrometer. Reading should be 1.250 to 1.290 at 70 F. If reading is less than 1.250, charge battery on a battery charger.

2. Test voltage of battery with a voltmeter. It should register 6 volts. Recharge if less than 6 volts. Replace or rebuild battery if all cells do not have the same voltage.

(b) Battery Voltage Drop.

VOLTMETER
WIRE BRUSH

1. Connect a voltmeter positive lead to battery positive terminal. Connect voltmeter negative lead to battery negative terminal. Turn ignition switch off. Press starter switch and note voltmeter reading.

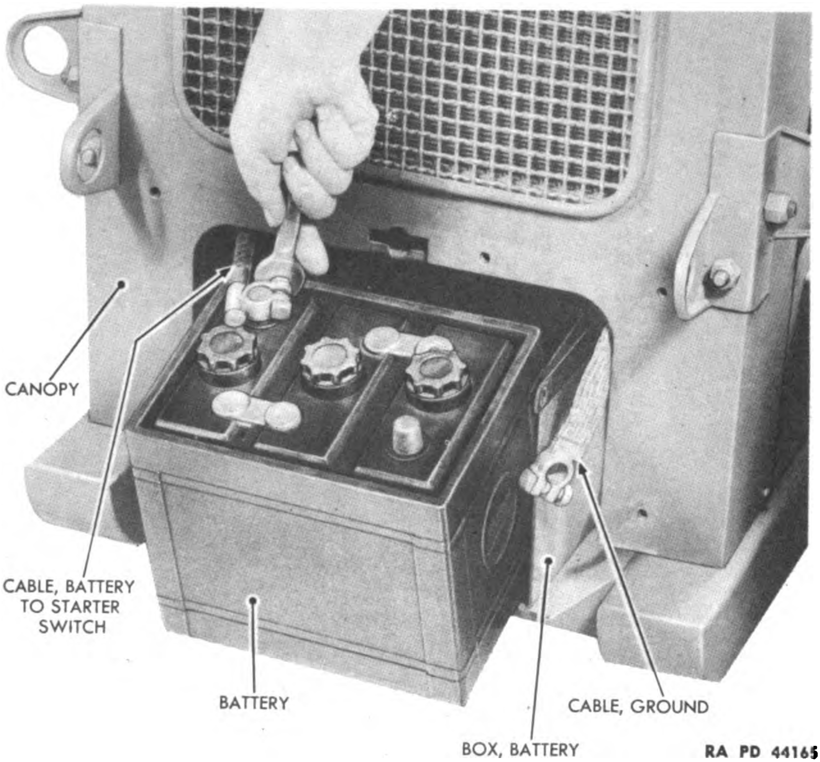

Figure 132 — Removing Battery

(16) Assemble commutator cover band (B) with screw (C), and nut (A) to starting motor (screwdriver) (fig. 131).

(17) Connect starting motor to a battery, and operate for running test to be sure all repairs have been satisfactorily made. If starting motor fails to operate, disassemble it; locate and repair trouble (steps (1) through (17) above).

112. STARTING MOTOR INSTALLATION.

a. Equipment.

WRENCH, open-end, 9/16-in.

b. Procedure (fig. 124).

(1) Place starting motor in position on bell housing.

(2) Install the three starting motor mounting cap screws and lock washers (9/16-in. open-end wrench).

(3) Connect cable to starting motor terminal. Install starting motor terminal nut (9/16-in. open-end wrench).

113. BATTERY.

a. Equipment.

CHARGER, battery
HYDROMETER
SCREWDRIVER
TESTER, battery cell
VOLTMETER
WIRE brush
WRENCH, open-end, ½-in. (2)
WRENCH, open-end, 9/16-in.

b. Procedure.

(1) REMOVAL (fig. 132).

SCREWDRIVER
WRENCH, open-end, 9/16-in.
WRENCH, open-end, ½-in. (2)

(a) Remove battery cover from housing (screwdriver) (fig. 1).

(b) Remove battery clamp bolt which secures battery in battery box (two ½-in. open-end wrenches).

(c) Slide battery forward, and remove battery cables from battery (9/16-in. open-end wrench). NOTE: Remove ground (negative) cable first.

(2) INSPECTION AND REPAIR.

CHARGER, battery
TESTER, battery cell

(a) Recharge the battery (battery charger).

(b) Allow battery to stand for 24 hours after removal from battery charger.

(c) Test each cell of battery. If any cell is dead or weaker than the rest, replace or rebuild battery.

(3) TEST.

HYDROMETER
VOLTMETER
WIRE BRUSH

(a) Battery Capacity.

HYDROMETER
VOLTMETER

1. Take a specific gravity reading with a hydrometer. Reading should be 1.250 to 1.290 at 70 F. If reading is less than 1.250, charge battery on a battery charger.

2. Test voltage of battery with a voltmeter. It should register 6 volts. Recharge if less than 6 volts. Replace or rebuild battery if all cells do not have the same voltage.

(b) Battery Voltage Drop.

VOLTMETER
WIRE BRUSH

1. Connect a voltmeter positive lead to battery positive terminal. Connect voltmeter negative lead to battery negative terminal. Turn ignition switch off. Press starter switch and note voltmeter reading.

2. Connect voltmeter positive lead to a clean place on the engine. Connect voltmeter negative lead to the starter switch battery terminal. Turn the ignition switch off. Press starting motor switch and note voltmeter reading. The difference between voltmeter readings in this and the immediately preceding step should not exceed 0.25 volt. If it is higher, remove battery cables, and clean cable connections with a wire brush.

(c) Battery Cable and Cable Connections.

VOLTMETER

1. Connect voltmeter positive lead to the battery positive terminal. Connect voltmeter negative lead to a clean ground on the engine. Press starting motor switch and read voltmeter. The reading should not exceed 0.1 volt. If it is higher, clean and tighten battery cable connections.

2. Connect voltmeter positive lead to battery terminal of the starting motor switch. Connect voltmeter negative lead to the battery negative terminal. Press starter switch and read voltmeter. Reading should not exceed 0.1 volt. If it is higher, clean and tighten battery cable connections.

(4) INSTALLATION (fig. 132).

SCREWDRIVER
WRENCH, open-end, ½-in. (2)
WRENCH, open-end, 9/16-in.

(a) Slide battery into battery box. Be sure battery post marked "-" is on side of ground cable.

(b) Connect starter switch cable to positive battery post (½-in. open-end wrench).

(c) Connect ground cable to negative battery post (½-in. open-end wrench).

(d) Push battery to back of battery box and install battery clamp bolt (two ½-in. open-end wrenches).

(e) Install battery cover (screwdriver) (fig. 1).

Section XIV

ENGINE REMOVAL AND DISASSEMBLY

114. REMOVAL.

a. Equipment.

HOIST, chain	WRENCH, open-end, 9/16-in.
SCREWDRIVER	WRENCH, open-end, 5/8-in.
WRENCH, open-end, 3/8-in.	WRENCH, open-end, 3/4-in.
WRENCH, open-end, 1/2-in.	WRENCH, Stillson

b. Procedure.

(1) Remove oil drain pipe cap and drain oil from engine (Stillson wrench) (fig. 3). Remove bayonet oil gage (fig. 117).

(2) Remove housing (par. 14).

(3) Remove battery (par. 113).

(4) Remove radiator (par. 78).

(5) Remove main generator and instrument panel assembly (par. 23 **b** (2) through (14)) (figs. 134 and 135).

(6) Remove drain cock (5/8-in. open-end wrench).

(7) Remove rear engine mounting cap screws and lock washers (3/4-in. open-end wrench) (fig. 134). Also remove front engine mounting bracket to frame, cap screws, and lock washers (fig. 134) with same wrench.

(8) Lift engine from frame to work bench (two men).

115. ACCESSORIES, REMOVAL.

a. Equipment.

DRIFT, small	WRENCH, box, 1/2-in.
HAMMER	WRENCH, open-end, 3/8-in.
HAMMER, soft	WRENCH, open-end, 1/2-in.
PILOT, special	WRENCH, open-end, 9/16-in.
PRESS, arbor	WRENCH, open-end, 11/16-in.
PULLER, gear	WRENCH, socket, 1/2-in.
REMOVER, stud	WRENCH, socket, 9/16-in.
SCREWDRIVER	WRENCH, Stillson

b. Procedure.

(1) REMOVE MUFFLER.

WRENCH, Stillson

Remove muffler from exhaust pipe adapter (Stillson wrench) (fig. 136).

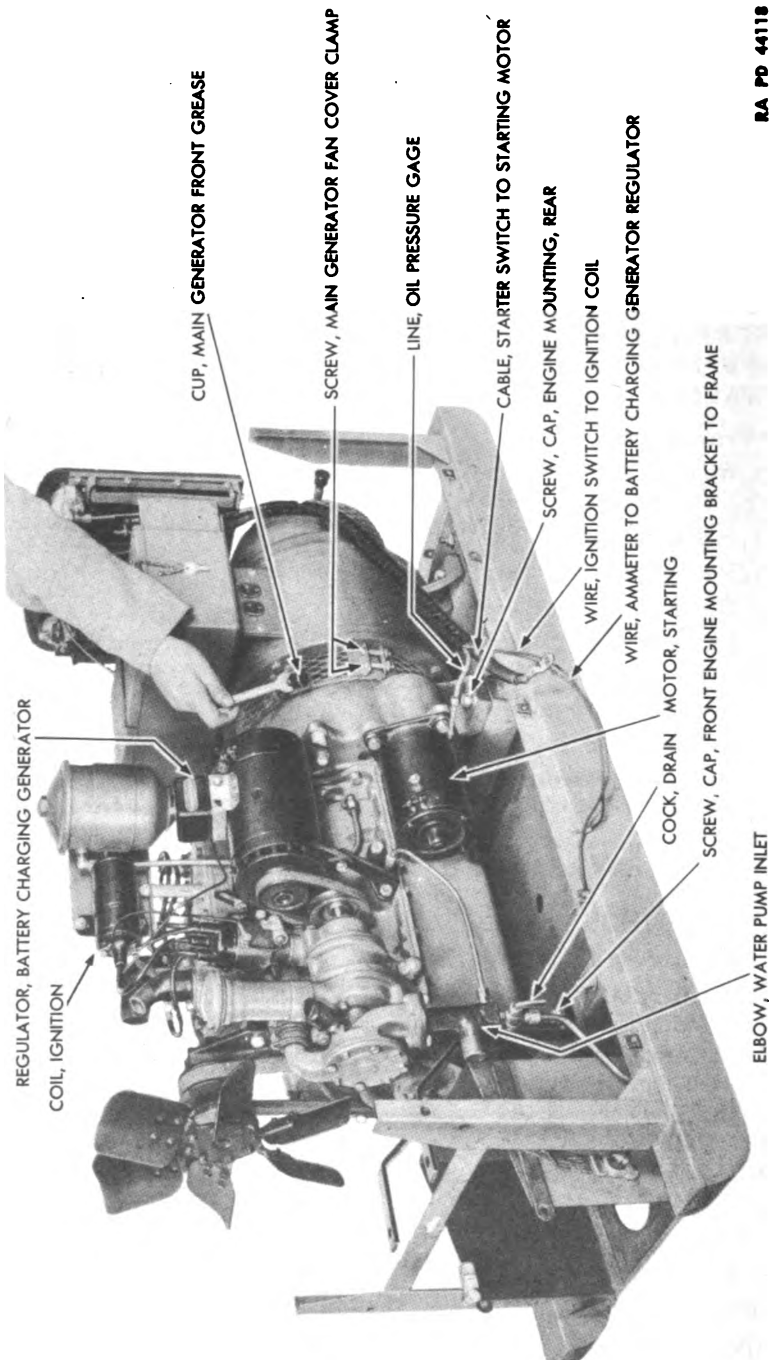

Figure 133 — Disconnecting Engine for Removal

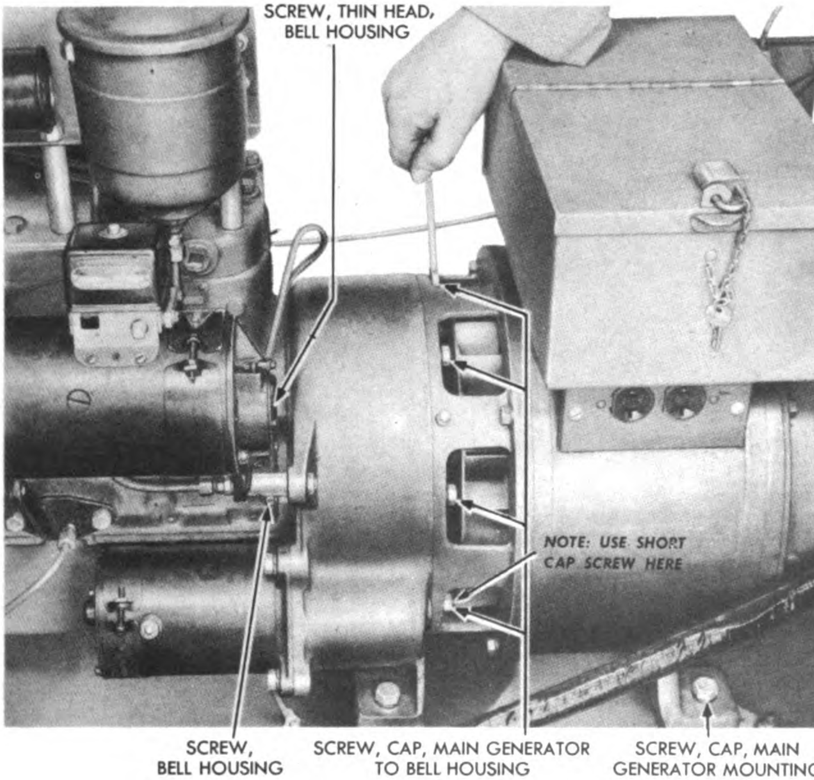

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Figure 134 — Removing Main Generator to Bell Housing Cap Screws

(2) REMOVE EXHAUST PIPE ADAPTER.

WRENCH, open-end, $\frac{9}{16}$-in.

Remove exhaust pipe adapter to manifold cap screws and lock washers ($\frac{9}{16}$-in. open-end wrench). Lift exhaust pipe adapter from manifold (fig. 136).

(3) REMOVE FAN AND FAN BELT (par. 79).

(4) REMOVE WATER PUMP AND WATER PUMP DISCHARGE PIPE HOSE.

SCREWDRIVER

Remove water pump (par. 72) and water pump discharge pipe hose (screwdriver). To prevent breaking water discharge bracket, bottom stud should be removed first and replaced last.

(5) REMOVE WATER OUTLET ELBOW.

WRENCH, open-end, ½-in.

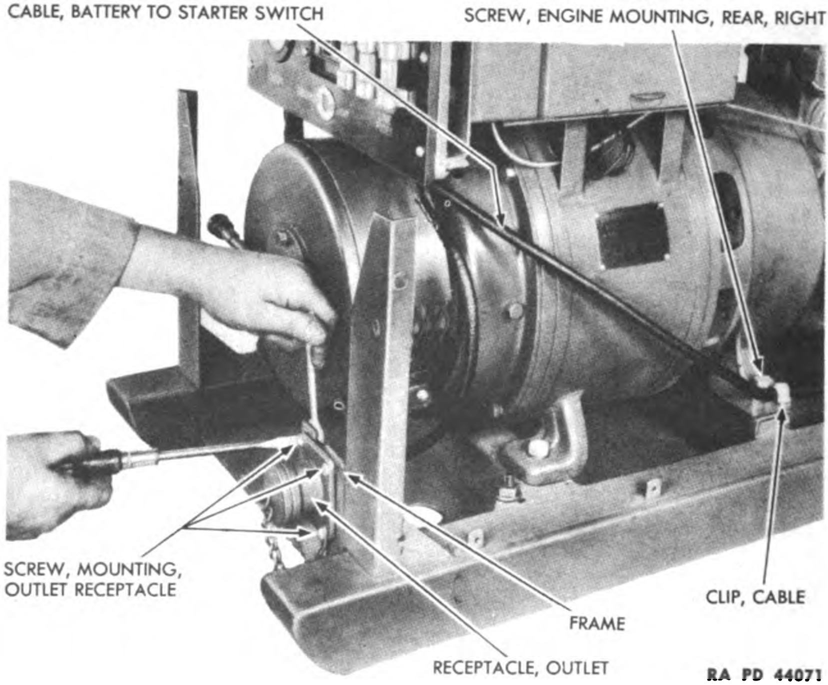


Figure 135 — Removing Outlet Receptacle

Remove water outlet elbow to cylinder head cap screws and lock washers (½-in. open-end wrench). Lift water outlet elbow gasket and thermostat from cylinder head (fig. 136).

(6) Remove Distributor (par. 98).

(7) Remove Battery Charging Generator Regulator (par. 88).

(8) Remove Battery Charging Generator (par. 83).

(9) Remove Water Pump Discharge Pipe.

WRENCH, socket, ½-in.

Remove water pump discharge pipe to cylinder block cap screws and lock washers (½-in. socket wrench). Lift battery charging generator adjustable bracket, water pump discharge pipe, and gasket from cylinder block (fig. 137).

(10) Remove Water Bypass Tube.

WRENCH, open-end, ½-in.

Remove water bypass tube from thermo-siphon cover and generator bracket (½-in. open-end wrench) (fig. 137).

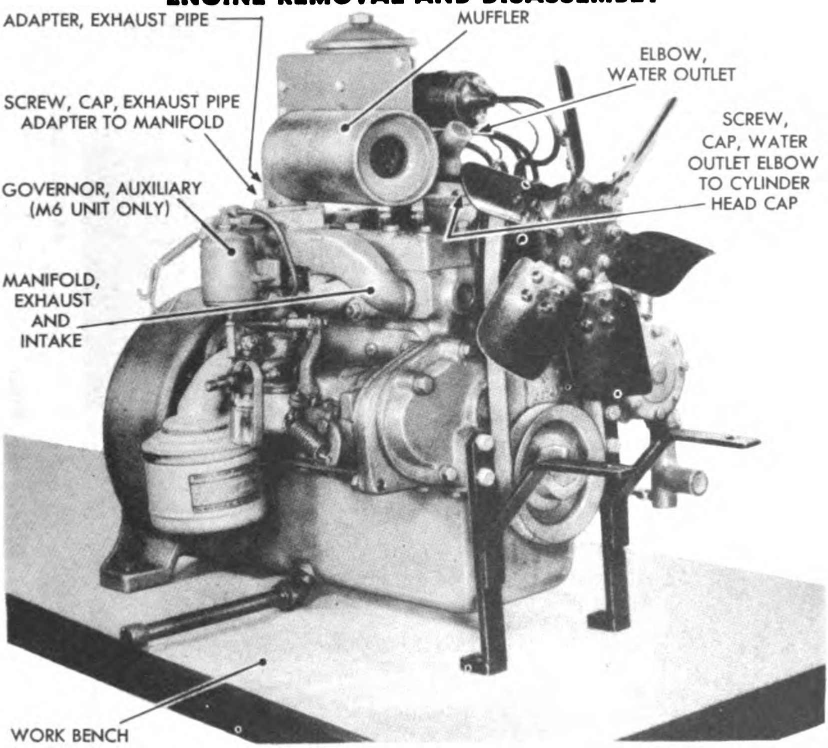


Figure 136 — Position of Engine for Removal of Acccessories

(11) Remove Generator Support Bracket.

WRENCH, socket, 9/16-in.

Remove generator support bracket to cylinder block cap screws and lock washers (9/16-in. socket wrench). Lift bracket and gasket from cylinder block (fig. 137).

(12) Remove Ignition Coil (par. 97).

(13) Remove Oil Filter and Fittings.

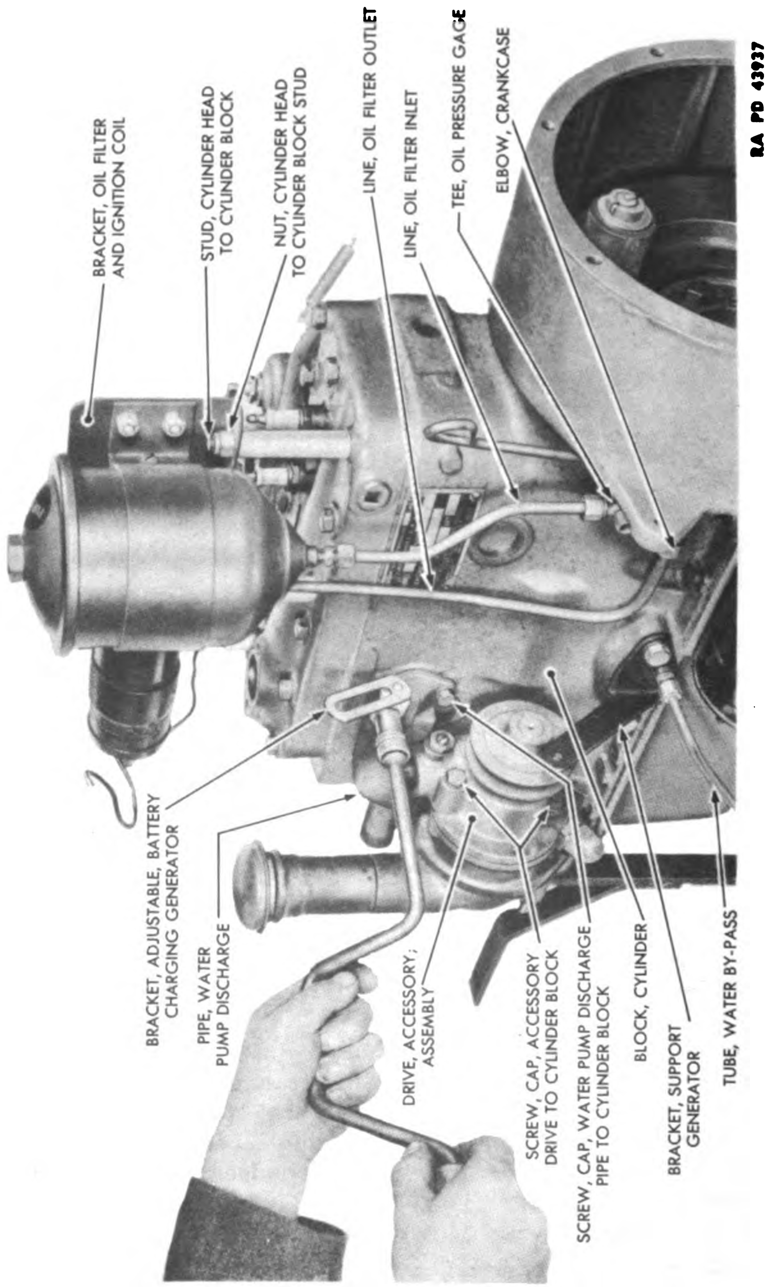
WRENCH, open-end, 3/8-in. WRENCH, open-end, 9/16-in.
WRENCH, open-end, 1/2-in.

Remove oil filter (par. 159), oil filter outlet line (to crankcase elbow), and oil filter inlet line (to oil pressure gage "T") (9/16-in. open-end wrench). Drain oil from filter into a suitable container. Remove oil pressure gage "T" from cylinder block (1/2-in. open-end wrench). Remove crankcase elbow from cylinder block (3/8-in. open-end wrench) (fig. 137).

(14) Remove Starting Motor (par. 108).

(15) Remove Accessory Drive.

WRENCH, box, 1/2-in.



Fgiure 137 — Removing Water Pump Discharge Pipe

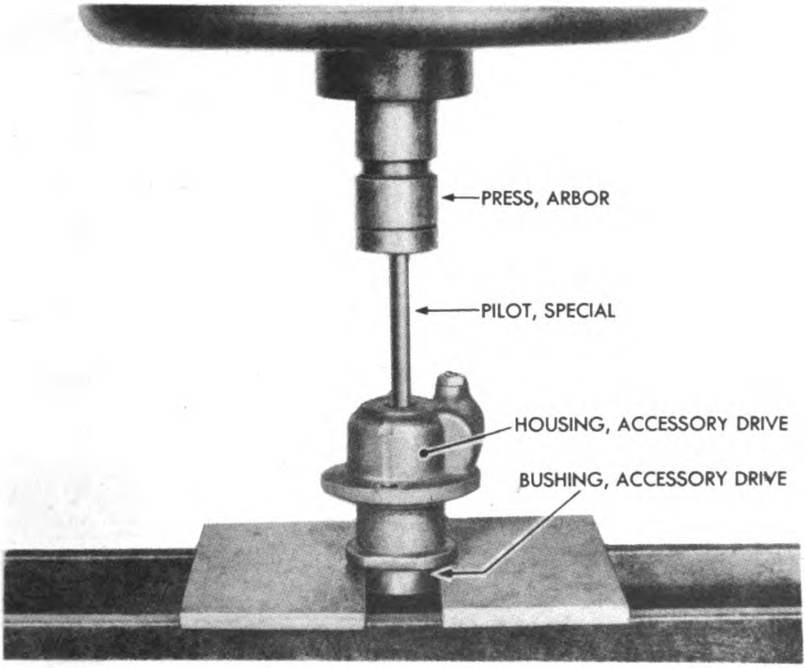


Figure 138 — Pressing Accessory Drive Bushing from Accessory Drive Housing

Remove the two accessory drive to cylinder block cap screws and lock washers (½-in. box wrench). Lift accessory drive assembly and gasket from cylinder block (fig. 137).

(16) Disassemble Accessory Drive.

DRIFT, small	PRESS, arbor
HAMMER	PULLER, gear
HAMMER, soft	SCREWDRIVER
PILOT, special	WRENCH, open-end, $1\frac{1}{16}$-in.

(a) Using a small drift and a hammer, drive the generator drive pulley tapered pin from pulley and shaft. NOTE: Be sure to drive on small end of pin.

(b) Using a puller, remove generator drive pulley from accessory drive shaft. Tap generator drive pulley Woodruff key from shaft with a soft hammer.

(c) Press generator drive pulley from accessory drive shaft (arbor press). Tap Woodruff key from shaft (soft hammer).

(d) Push accessory drive shaft assembly from accessory drive housing.

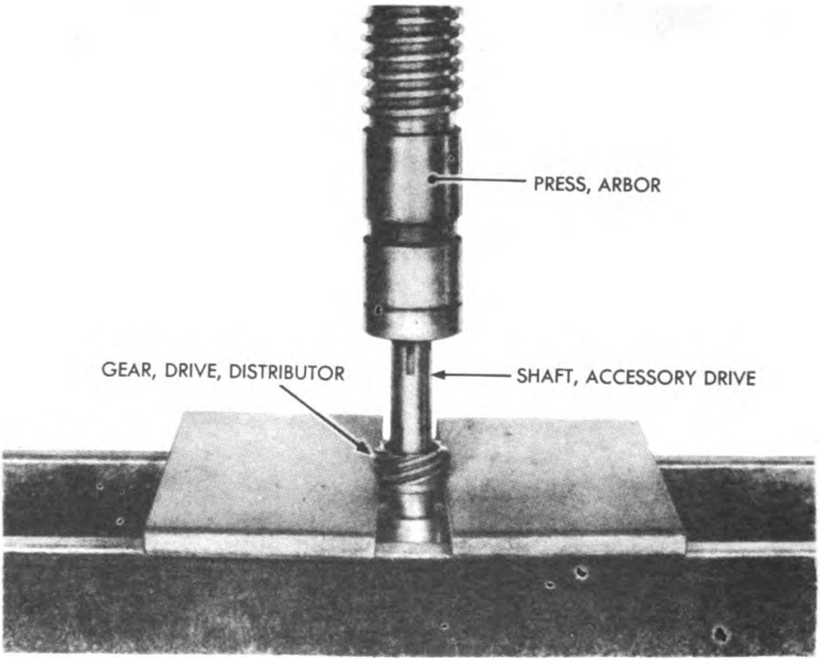


Figure 139 — Pressing Distributor Drive Gear from Accessory Drive Shaft

(e) Press accessory drive bushing from accessory drive housing (arbor press and special pilot) (fig. 138). This is done by inserting disk (fig. 226) through the bushing, into the housing. Turn it over so that it rests flat on top of bushing. Insert rod through opening in top of housing, and press against disk (fig. 138). The disk forces bushing from housing.

(f) Using a small drift and a hammer, tap accessory drive oil retainer and accessory drive cork washer from accessory drive housing.

(g) Lift accessory drive thrust washer from accessory drive shaft.

(h) Press the distributor drive gear from accessory drive shaft (arbor press) (fig. 139). Tap distributor drive gear key from shaft (soft hammer).

(i) Press the accessory drive gear from accessory drive shaft (arbor press) (fig. 140). Tap accessory drive gear key from shaft (soft hammer).

(j) Remove distributor setscrew and lock nut from accessory drive housing (screwdriver). Remove lock nut from setscrew ($^{11}/_{16}$-in. open-end wrench).

(17) REMOVE AIR CLEANER (par. 136).

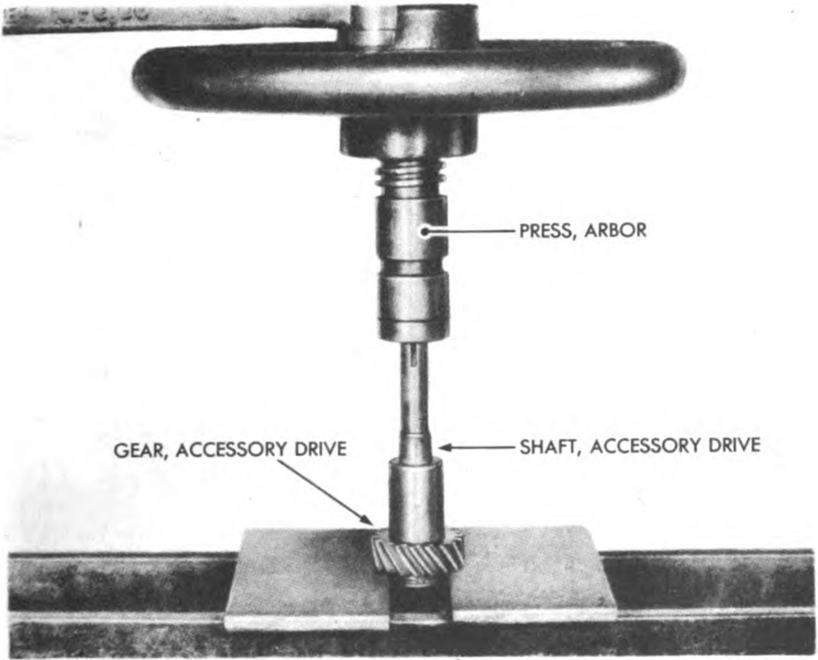


Figure 140 — Pressing Accessory Drive Gear from Accessory Drive Shaft

(18) REMOVE GASOLINE STRAINER (par. 155).

(19) REMOVE VACUUM THROTTLE CONTROL (Unit M6 only) (par. 149).

(20) REMOVE CARBURETOR (par. 137).

(21) REMOVE GOVERNOR (par. 143).

(22) REMOVE MANIFOLD.

WRENCH, socket, $\frac{9}{16}$-in.

Remove four manifold to cylinder block stud nuts and flat washers ($\frac{9}{16}$-in. socket wrench) (fig. 188). Lift exhaust and intake manifold from cylinder block. Lift manifold gaskets from cylinder block.

(23) REMOVE SPARK PLUGS (par. 104).

(24) REMOVE OIL FILLER CAP.

Lift oil filler cap from breather pipe.

(25) REMOVE OIL FILTER AND IGNITION COIL BRACKET.

REMOVER, stud WRENCH, open-end, $\frac{9}{16}$-in.

Remove the two stud nuts which secure oil filter and ignition coil bracket to cylinder head ($\frac{9}{16}$-in. open-end wrench). Lift bracket and

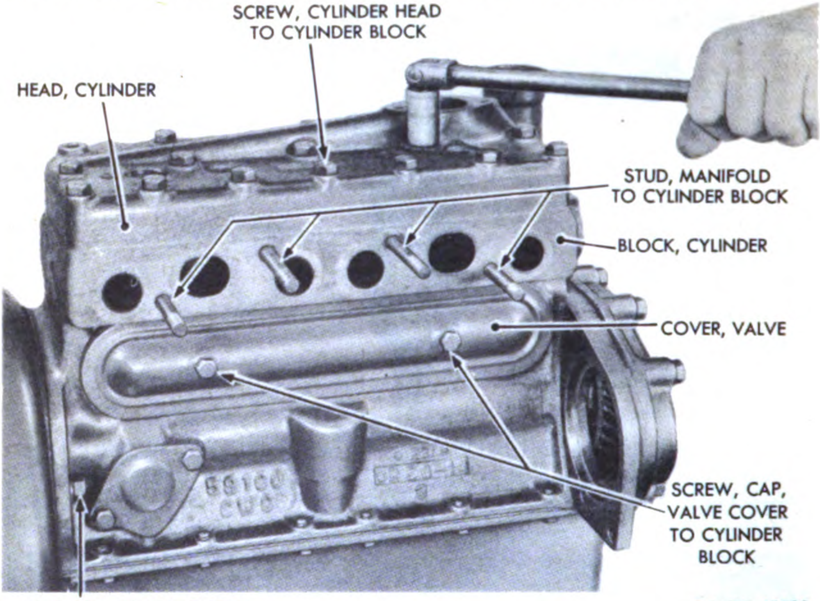


Figure 141 — Removing Cylinder Head

two bracket spacers from studs (fig. 137). Remove studs (stud remover).

(26) REMOVE OIL DRAIN PIPE.

WRENCH, Stillson

Remove oil drain pipe from oil drain pipe elbow (Stillson wrench) (fig. 136).

116. DISASSEMBLY.

a. Equipment.

DRIFT
DRIFT, soft
DRILL, electric
EXPANDER, piston ring
HAMMER
HAMMER, soft
LIFTER, valve
PLIERS, thin-nosed
PRESS, arbor
PULLER, gear
REMOVER, stud
REMOVER, valve guide
SCREWDRIVER
WOOD BLOCK
WRENCH, box, 9/16-in.
WRENCH, open-end, 3/8-in.
WRENCH, open-end, 7/16-in.
WRENCH, open-end, 9/16-in.
WRENCH, open-end, 13/16-in.
WRENCH, socket, 7/16-in.
WRENCH, socket, 1/2-in.
WRENCH, socket, 9/16-in.
WRENCH, socket, 5/8-in.
WRENCH, socket, 3/4-in.
WRENCH, Stillson

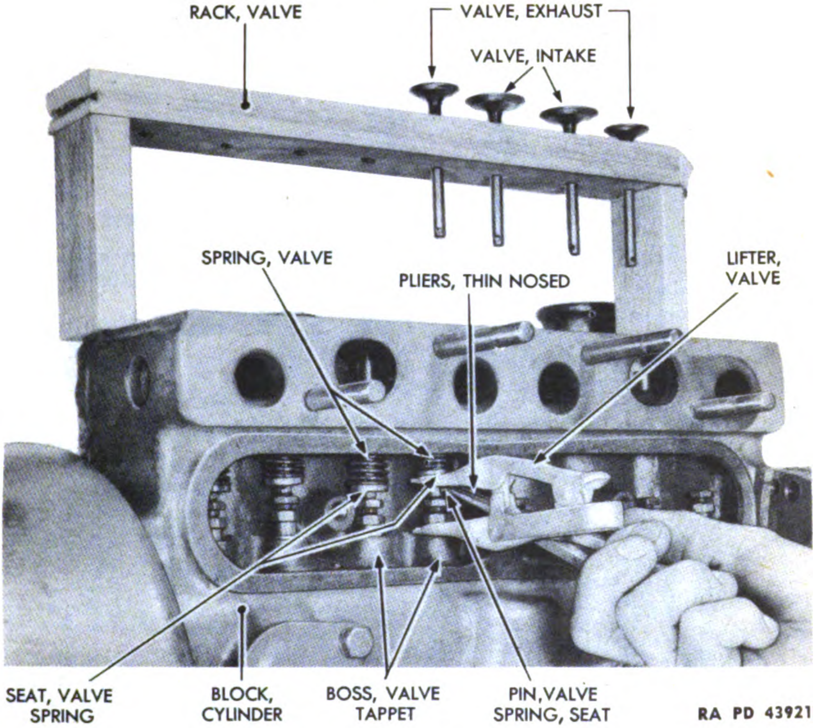


Figure 142 — Removing a Valve

b. Procedure.

(1) Remove Cylinder Head.

WRENCH, socket, 9/16-in.

(a) Remove 16 cylinder head to cylinder block cap screws (9/16-in. socket wrench) (fig. 141).

(b) Lift cylinder head and cylinder head gasket from cylinder block.

(2) Remove Valves.

LIFTER, valve
PLIERS, thin-nosed
WRENCH, socket, ½-in.

(a) Remove the two valve cover to cylinder block cap screws (½-in. socket wrench). Lift valve cover and gasket from cylinder block (fig. 141).

(b) Insert valve lifter between valve tappet boss and valve spring seat. Compress valve spring. Using thin-nosed pliers, remove valve spring seat pin. Lift valve from top of cylinder block. Release valve lifter and remove from cylinder block. Lift valve spring seat and valve spring from cylinder block (fig. 142).

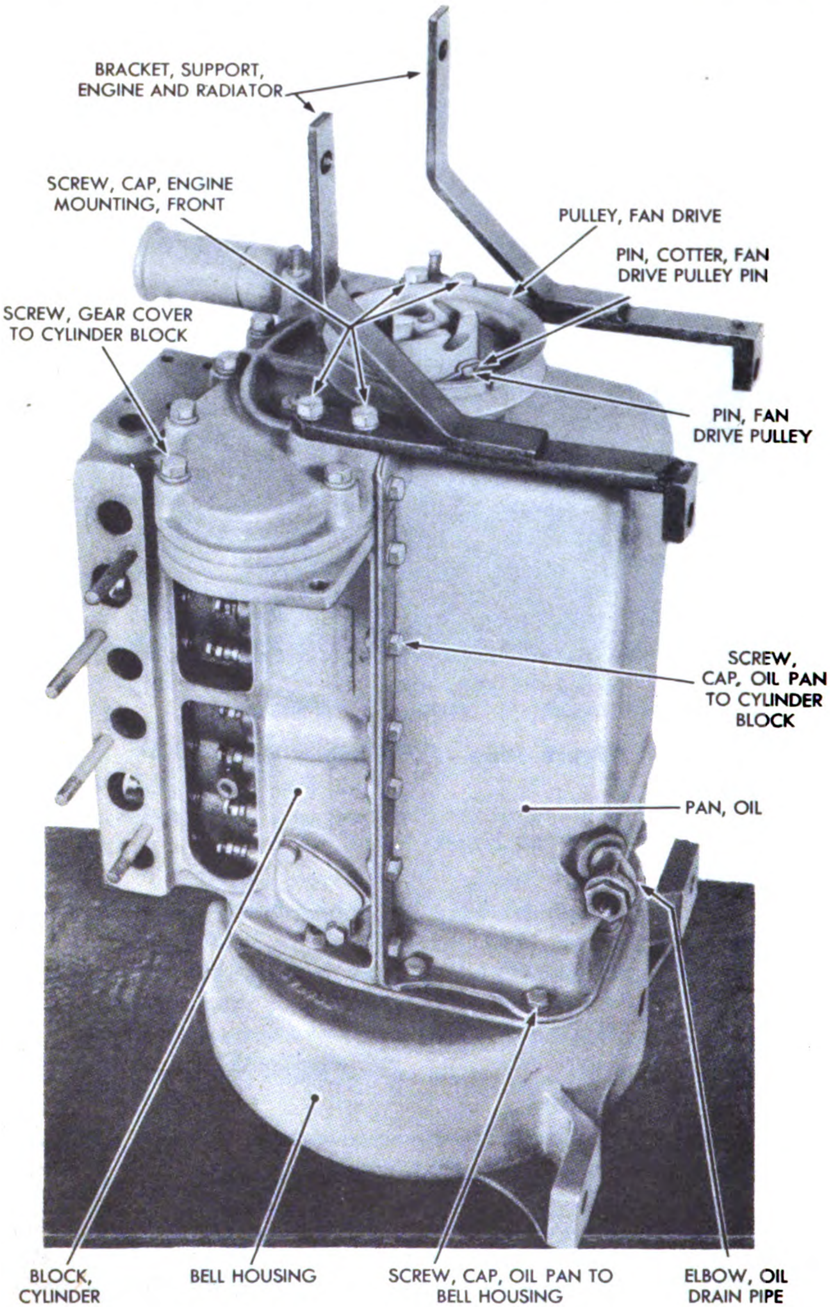


Figure 143 — Position of Engine for Further Disassembly

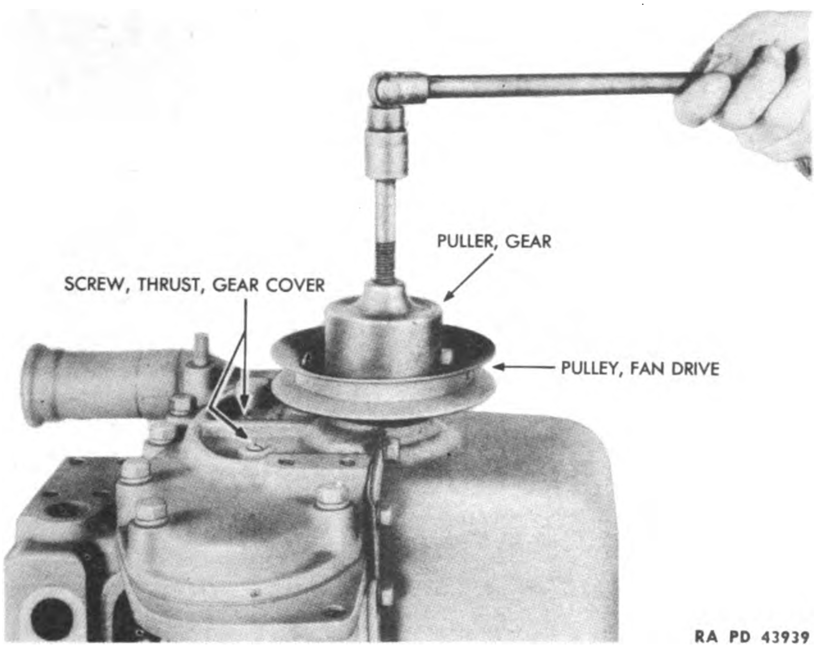


Figure 144 — Pulling Fan Drive Pulley

(c) Repeat substep *(b)* above, to remove each of seven remaining valves. NOTE: Valves must be kept in order so that they can be assembled in same cylinders from which they were removed. Construct a valve rack by drilling eight ¼-inch holes in a strip of wood. Saw a point on one end of strip to indicate front end. Place valves in proper hole upon removal from engine. This device will prevent confusion as to proper order of valves upon assembly (fig. 142).

(3) REMOVE VALVE GUIDES.

HAMMER REMOVER, valve guide

Remove valve guides by driving out from the top down (hammer and valve guide remover).

(4) REMOVE ENGINE AND RADIATOR SUPPORT BRACKETS.

WRENCH, box, $^9/_{16}$-in.

(a) Place engine on bell housing (fig. 143).

(b) Remove engine front mounting cap screws and lock washers which secure engine and radiator support brackets to gear cover ($^9/_{16}$-in. box wrench).

(c) Lift brackets from engine.

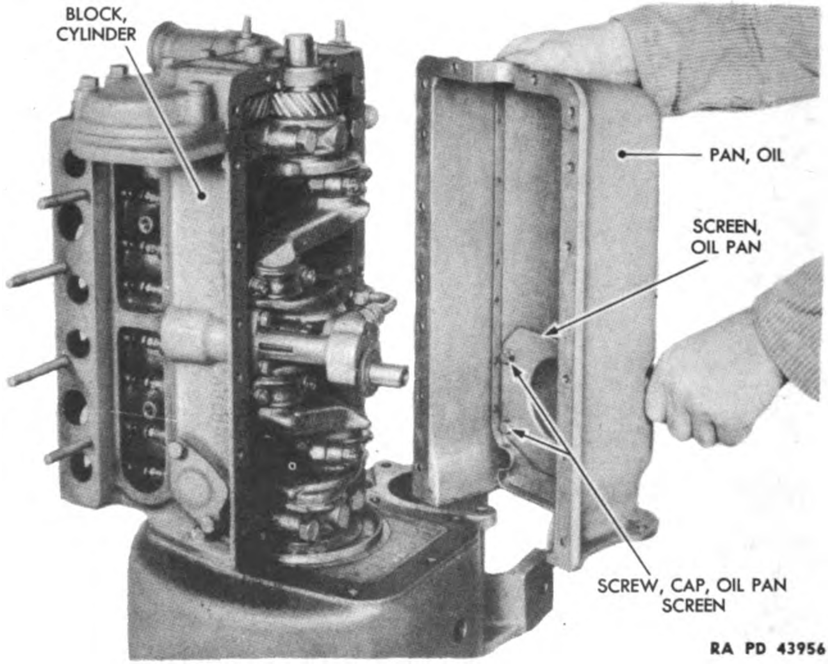


Figure 145 — Removing Oil Pan

(5) REMOVE FAN DRIVE PULLEY.

DRIFT	PLIERS, thin-nosed
HAMMER	PULLER, gear

(a) Using thin-nosed pliers, remove two fan drive pulley pin cotter pins (fig. 143).

(b) Drive fan drive pin from fan drive pulley (drift and hammer) (fig. 143).

(c) Pull fan drive pulley from front end of crankshaft (gear puller) (fig. 144).

(d) Tap Woodruff key from crankshaft (drift and hammer).

(6) REMOVE OIL PAN.

WRENCH, box, $^9/_{16}$-in.	WRENCH, socket, $^1/_2$-in.

(a) Remove oil pan to cylinder block cap screws and lock washers ($^1/_2$-in. socket wrench) (fig. 143).

(b) Remove oil pan to bell housing cap screws and lock washers ($^9/_{16}$-in. box wrench) (fig. 143).

(c) Lift oil pan and gaskets from cylinder block and bell housing (fig. 145).

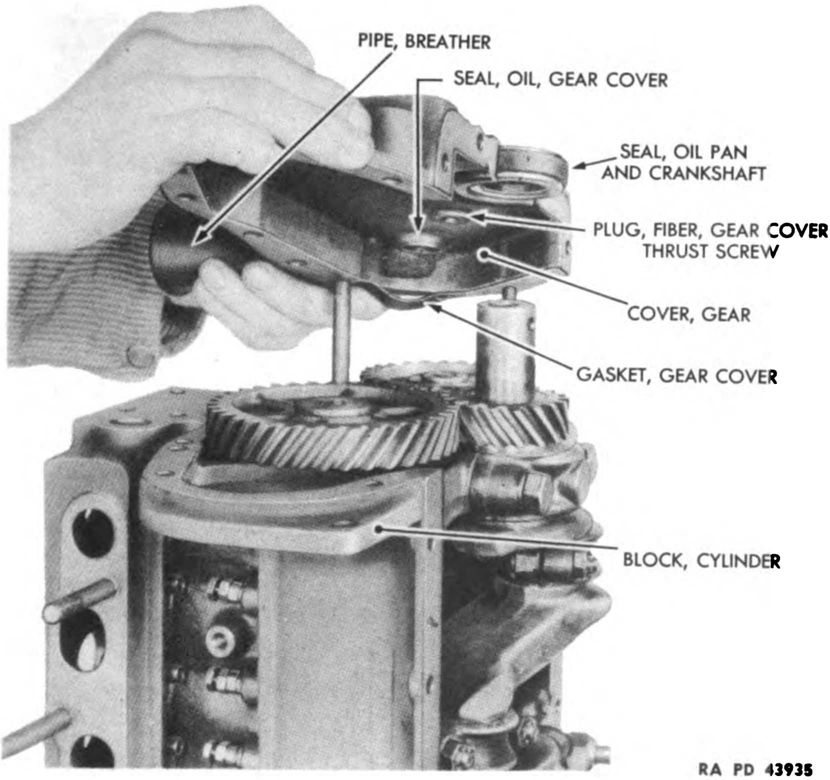


Figure 146 — Removing Gear Cover

(7) DISASSEMBLY OF OIL PAN.

WRENCH, socket, $^{7}/_{16}$-in. | WRENCH, Stillson

(a) Remove oil pan screen screws and lock washers which hold oil screen to oil pan ($^{7}/_{16}$-in. socket wrench) (fig. 145).

(b) Lift screen from oil pan.

(c) Remove oil drain pipe elbow from oil pan (Stillson wrench) (fig. 143).

(8) REMOVE GEAR COVER.

WRENCH, socket, $^{9}/_{16}$-in.

(a) Remove gear cover to cylinder block cap screws and lock washers ($^{9}/_{16}$-in. socket wrench) (fig. 143).

(b) Lift gear cover and gasket from cylinder block (fig. 146).

(9) DISASSEMBLE GEAR COVER.

DRIFT
DRIFT, soft
HAMMER
SCREWDRIVER
WRENCH, open-end, $^{13}/_{16}$-in.

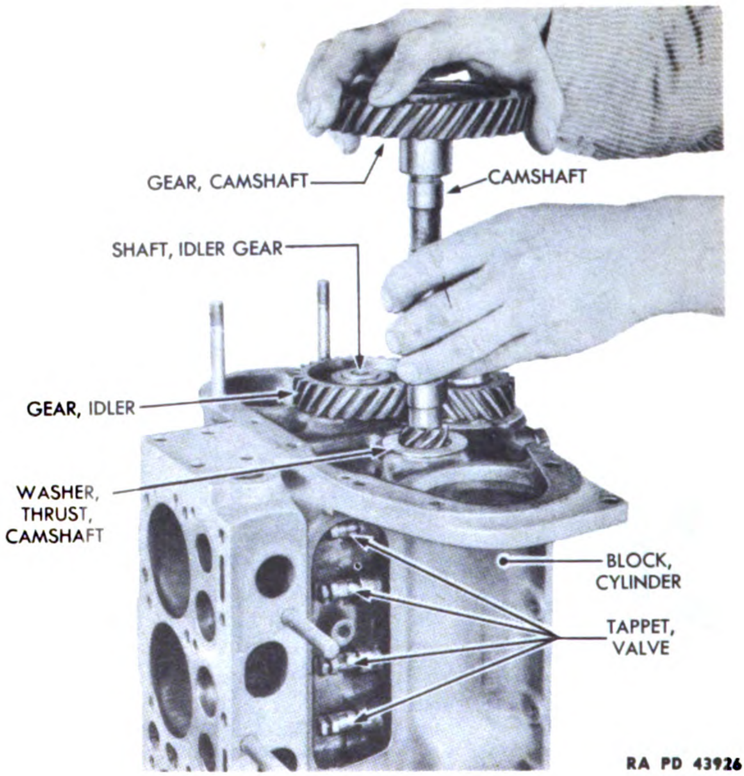


Figure 147 — Removing Camshaft

(a) Drive breather pipe from gear cover (soft drift and hammer) (fig. 146).

(b) Remove gear cover thrust screw assemblies from gear cover (screwdriver and 13/16-in. open-end wrench) (fig. 144).

(c) Drive gear cover thrust screw fiber plug from gear cover thrust screw (hammer and drift) (fig. 146). Repeat operation to remove other thrust screw.

(d) Tap oil pan and crankshaft seal from gear cover (drift and hammer) (fig. 146).

(e) Lift oil pan and crankshaft seal from gear cover (fig. 146).

(10) REMOVE OIL PUMP (par. 160).

(11) REMOVE CAMSHAFT AND IDLER GEAR.

(a) Pull all eight valve tappets away from camshaft. Lift camshaft gear and attached camshaft from cylinder block. Lift camshaft thrust washer from cylinder block (fig. 147).

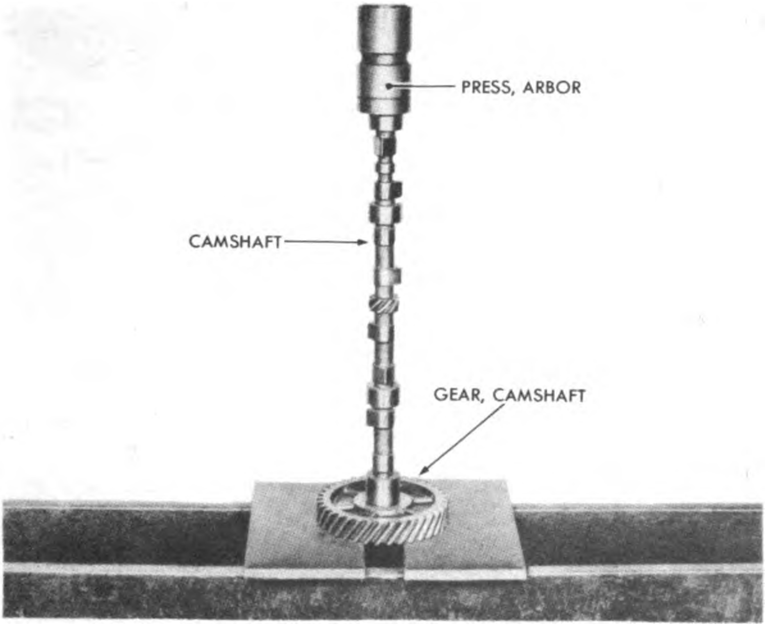


Figure 148 — Pressing Camshaft Gear Onto Camshaft

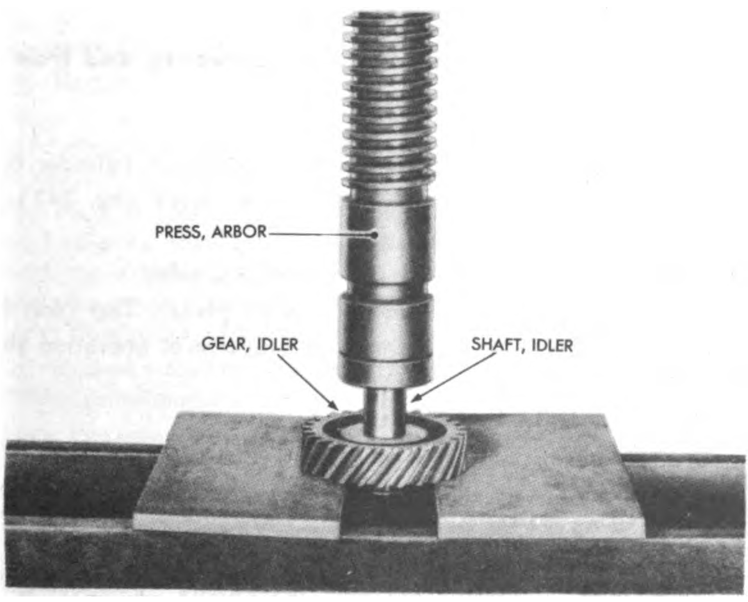


Figure 149 — Pressing Idler Gear from Idler Shaft

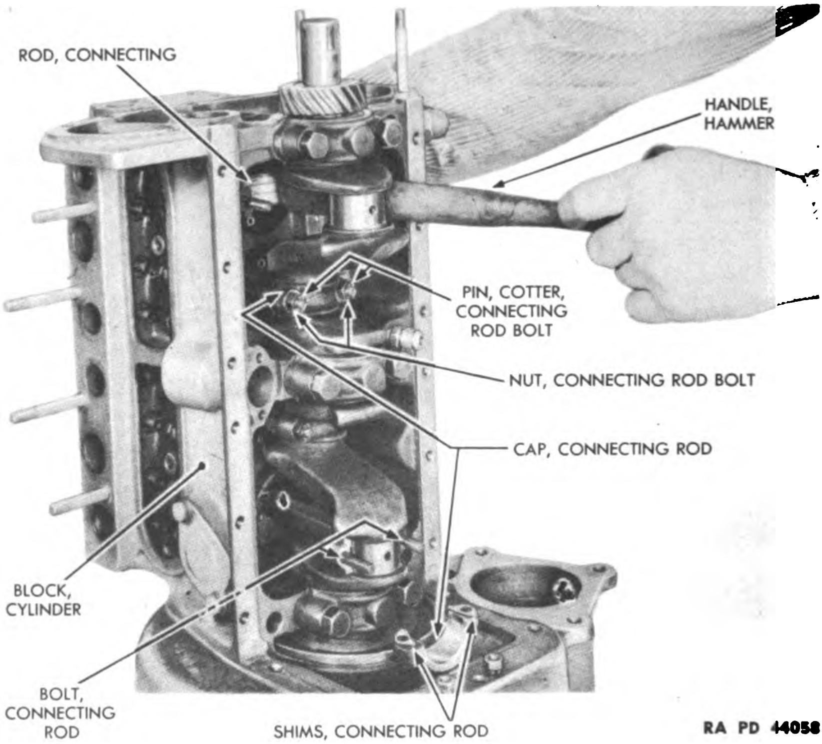


Figure 150 — Pushing Piston and Connecting Rod from Cylinder Block

(b) Lift idler gear and attached idler shaft from cylinder block. Pick idler shaft thrust washer from cylinder block (fig. 147).

(12) DISASSEMBLE CAMSHAFT.

HAMMER, soft PRESS, arbor

Press camshaft gear from camshaft (arbor press). Tap (soft hammer) camshaft gear key from camshaft (reverse of operation shown in fig. 148).

(13) DISASSEMBLE IDLER SHAFT.

PRESS, arbor

Press idler gear from idler shaft (arbor press) (reverse of operation shown in fig. 149).

(14) REMOVE PISTONS AND CONNECTING RODS.

HAMMER WRENCH, socket, ½-in.
PLIERS, thin-nosed

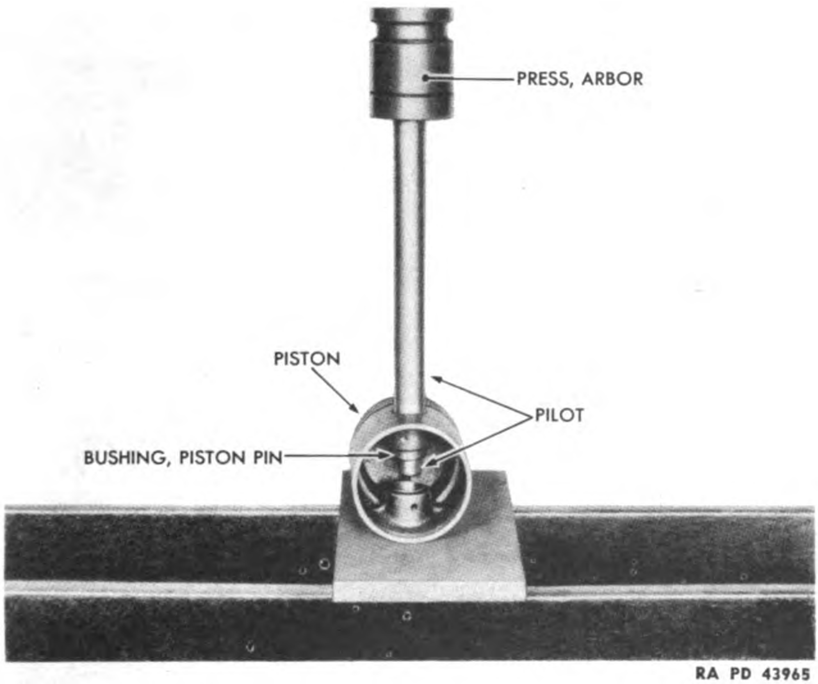


Figure 151 — Pressing Piston Pin Bushing from Piston

(a) Remove connecting rod bolt cotter pins from connecting rod (thin-nosed pliers) (fig. 150).

(b) Remove connecting rod bolt nuts ($\frac{1}{2}$-in. socket wrench) (fig. 150).

(c) Lift connecting rod cap and shims from connecting rod bolts (fig. 150).

(d) Place a hammer handle against end of connecting rod (*not against bearing surface*) and push connecting rod and piston out through top of cylinder block (fig. 150). NOTE: If engine is equipped with replacement pistons, be sure both rod and cap are marked with cylinder number on camshaft side of rod and cap.

(e) Repeat substeps *(a)* through *(d)* above, to remove each of the three remaining pistons and connecting rods.

(15) DISASSEMBLE PISTON AND CONNECTING ROD.

DRIFT, soft	PLIERS, thin-nosed
EXPANDER, piston ring	PRESS, arbor
HAMMER	WRENCH, socket, $\frac{7}{16}$-in.

(a) Remove two compression and one oil piston ring from piston (piston ring expander).

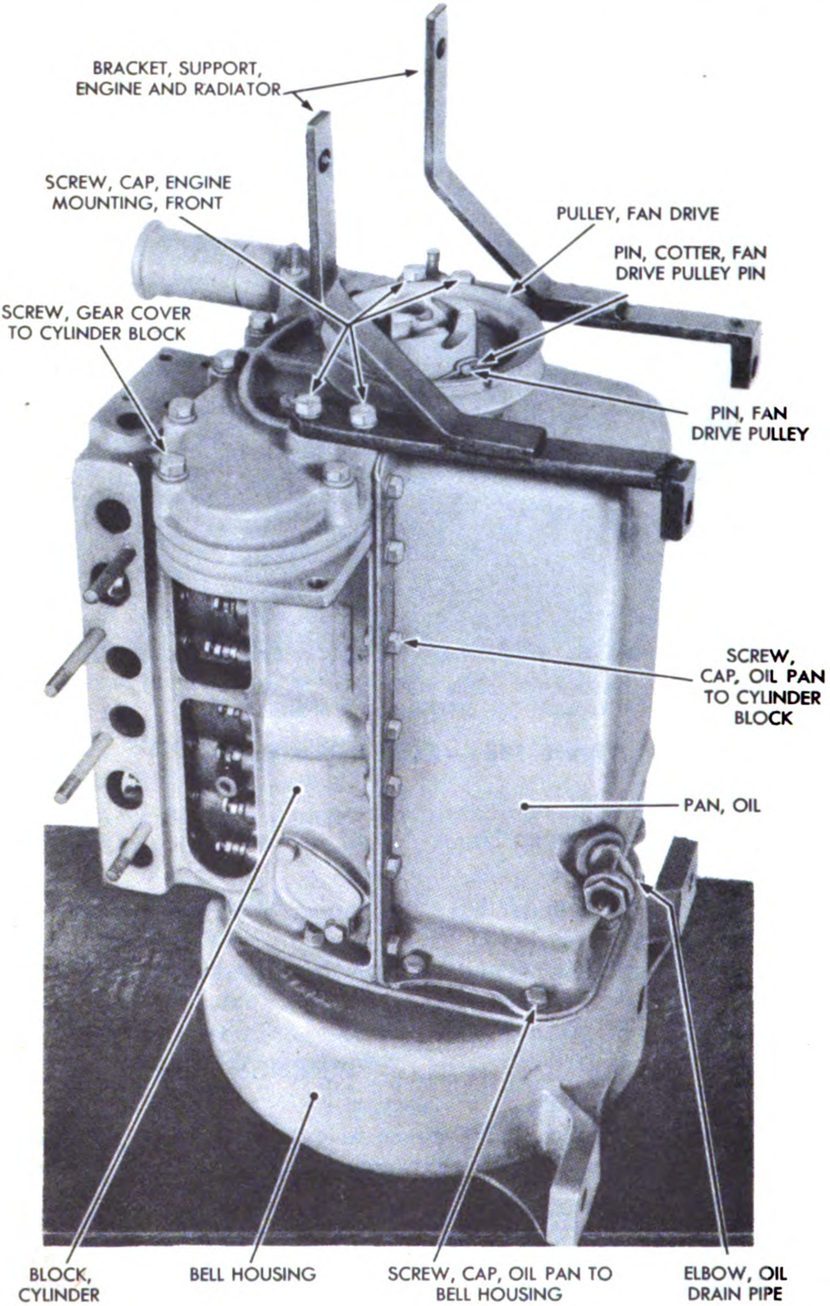


Figure 143 — Position of Engine for Further Disassembly

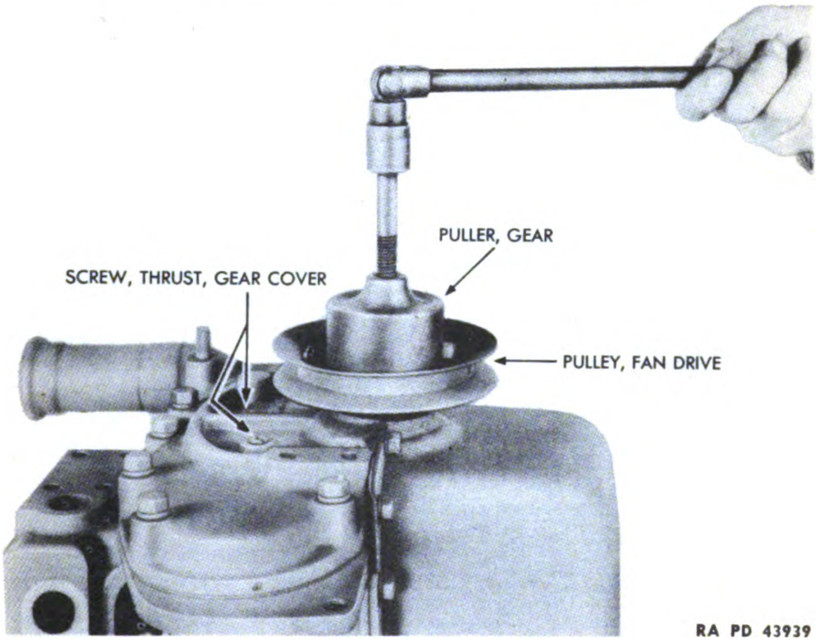


Figure 144 — Pulling Fan Drive Pulley

(c) Repeat substep *(b)* above, to remove each of seven remaining valves. NOTE: Valves must be kept in order so that they can be assembled in same cylinders from which they were removed. Construct a valve rack by drilling eight ¼-inch holes in a strip of wood. Saw a point on one end of strip to indicate front end. Place valves in proper hole upon removal from engine. This device will prevent confusion as to proper order of valves upon assembly (fig. 142).

(3) REMOVE VALVE GUIDES.

HAMMER   REMOVER, valve guide

Remove valve guides by driving out from the top down (hammer and valve guide remover).

(4) REMOVE ENGINE AND RADIATOR SUPPORT BRACKETS.

WRENCH, box, $^9/_{16}$-in.

(a) Place engine on bell housing (fig. 143).

(b) Remove engine front mounting cap screws and lock washers which secure engine and radiator support brackets to gear cover ($^9/_{16}$-in. box wrench).

(c) Lift brackets from engine.

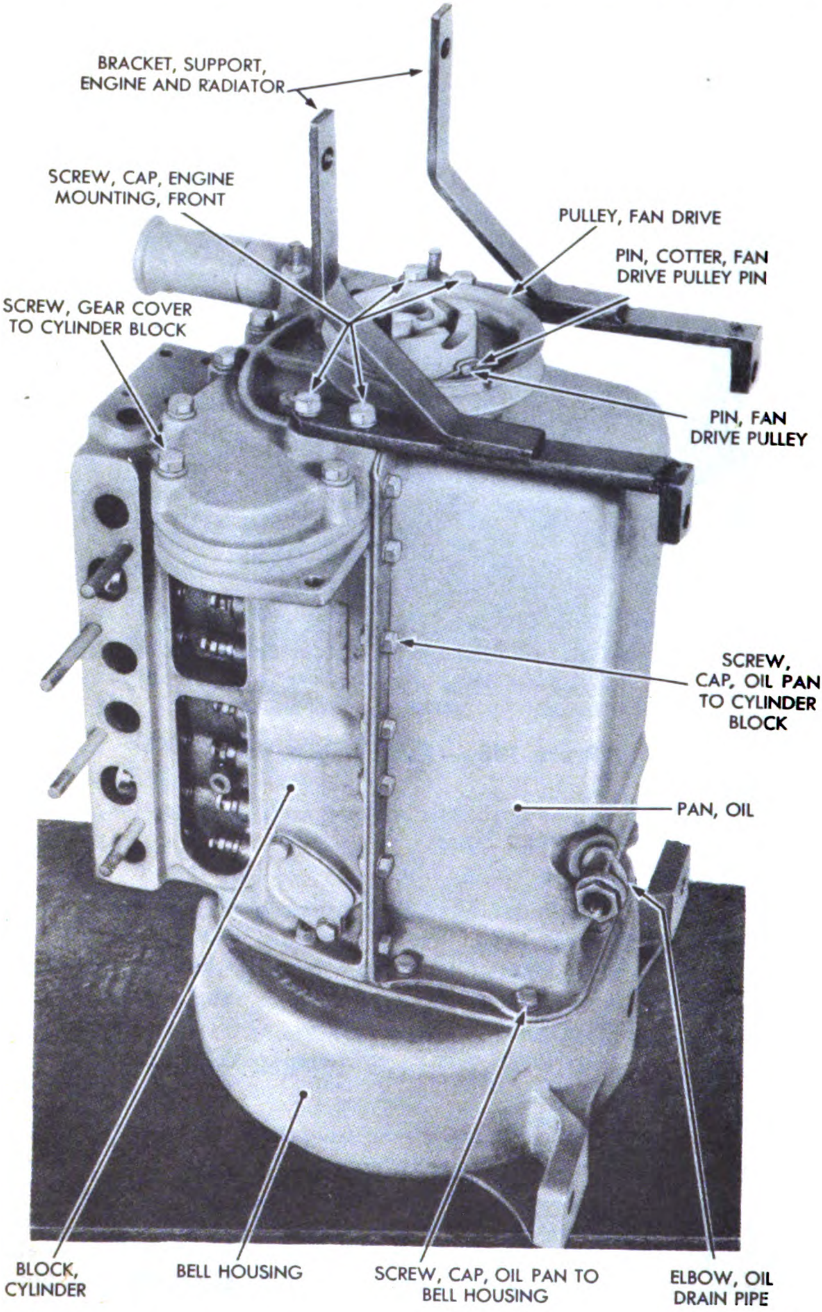


Figure 143 — Position of Engine for Further Disassembly

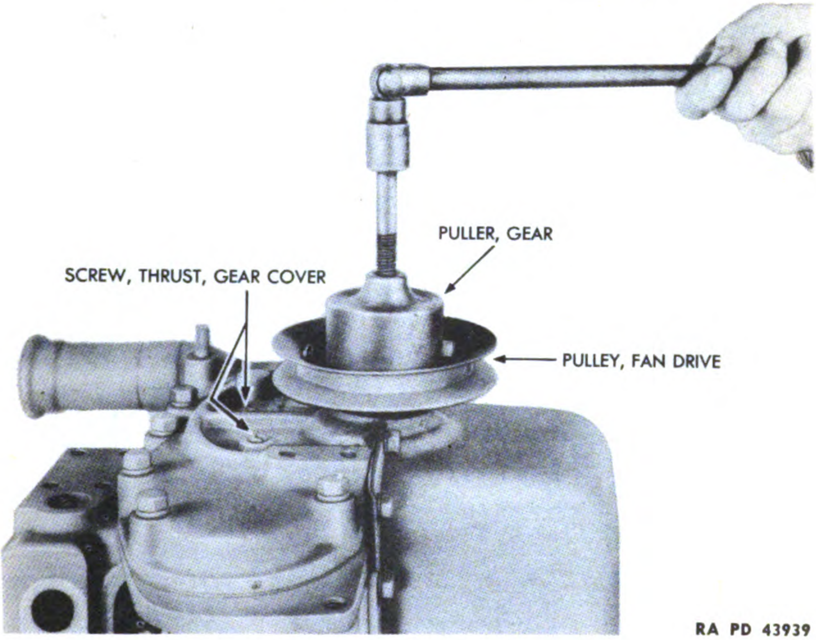


Figure 144 — Pulling Fan Drive Pulley

(c) Repeat substep *(b)* above, to remove each of seven remaining valves. NOTE: Valves must be kept in order so that they can be assembled in same cylinders from which they were removed. Construct a valve rack by drilling eight ¼-inch holes in a strip of wood. Saw a point on one end of strip to indicate front end. Place valves in proper hole upon removal from engine. This device will prevent confusion as to proper order of valves upon assembly (fig. 142).

(3) Remove Valve Guides.

HAMMER REMOVER, valve guide

Remove valve guides by driving out from the top down (hammer and valve guide remover).

(4) Remove Engine and Radiator Support Brackets.

WRENCH, box, $^9\!/_{16}$-in.

(a) Place engine on bell housing (fig. 143).

(b) Remove engine front mounting cap screws and lock washers which secure engine and radiator support brackets to gear cover ($^9\!/_{16}$-in. box wrench).

(c) Lift brackets from engine.

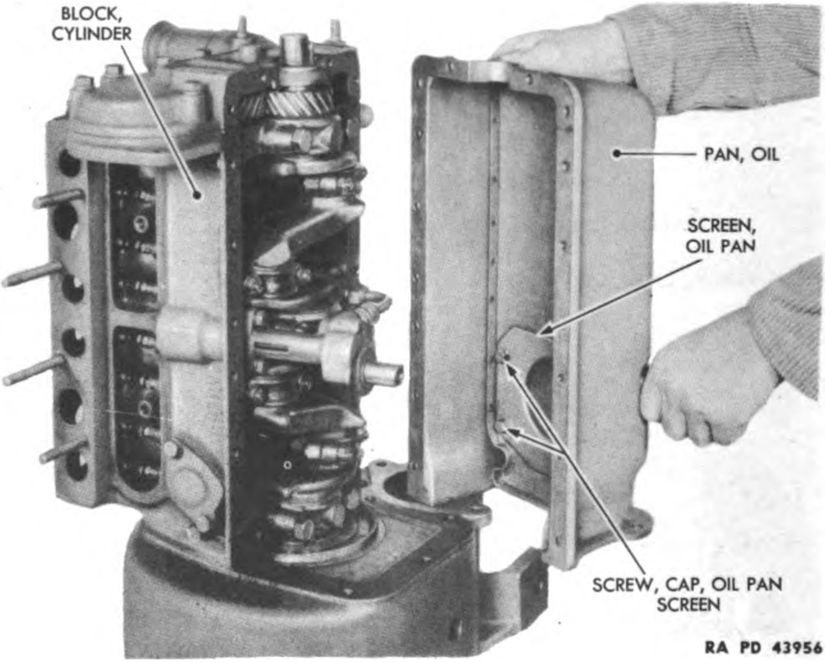


Figure 145 — Removing Oil Pan

(5) REMOVE FAN DRIVE PULLEY.

DRIFT	PLIERS, thin-nosed
HAMMER	PULLER, gear

(a) Using thin-nosed pliers, remove two fan drive pulley pin cotter pins (fig. 143).

(b) Drive fan drive pin from fan drive pulley (drift and hammer) (fig. 143).

(c) Pull fan drive pulley from front end of crankshaft (gear puller) (fig. 144).

(d) Tap Woodruff key from crankshaft (drift and hammer).

(6) REMOVE OIL PAN.

WRENCH, box, $^9/_{16}$-in.	WRENCH, socket, $^1/_2$-in.

(a) Remove oil pan to cylinder block cap screws and lock washers ($^1/_2$-in. socket wrench) (fig. 143).

(b) Remove oil pan to bell housing cap screws and lock washers ($^9/_{16}$-in. box wrench) (fig. 143).

(c) Lift oil pan and gaskets from cylinder block and bell housing (fig. 145).

ENGINE REMOVAL AND DISASSEMBLY

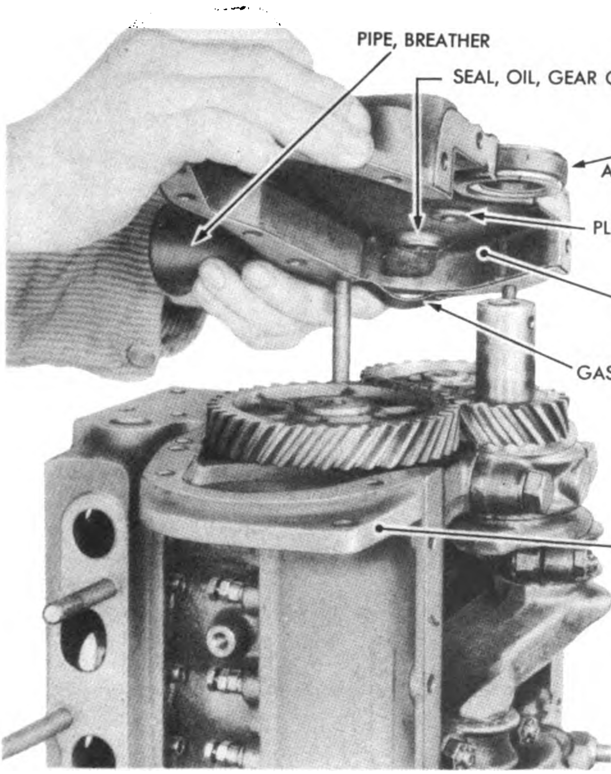


Figure 146 — Removing Gear Cover

(7) Disassembly of Oil Pan.

WRENCH, socket, 7/16-in. WRENCH, Stillson

(a) Remove oil pan screen screws and lock washers which hold oil screen to oil pan (7/16-in. socket wrench) (fig. 145).

(b) Lift screen from oil pan.

(c) Remove oil drain pipe elbow from oil pan (Stillson wrench) (fig. 143).

(8) Remove Gear Cover.

WRENCH, socket, 9/16-in.

(a) Remove gear cover to cylinder block cap screws and lock washers (9/16-in. socket wrench) (fig. 143).

(b) Lift gear cover and gasket from cylinder block (fig. 146).

(9) Disassemble Gear Cover.

DRIFT
DRIFT, soft
HAMMER
SCREWDRIVER
WRENCH, open-end, 13/16-in.

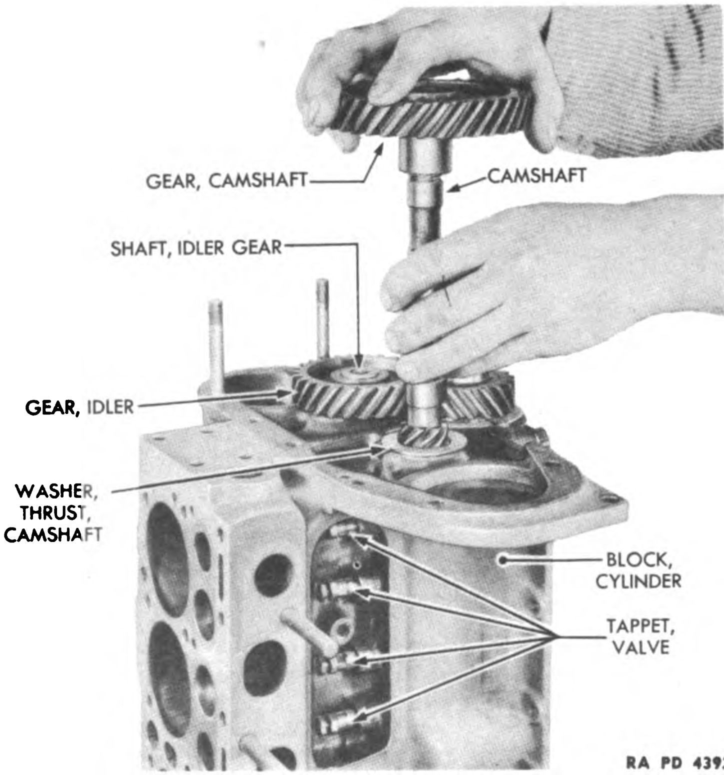


Figure 147 — Removing Camshaft

(a) Drive breather pipe from gear cover (soft drift and hammer) (fig. 146).

(b) Remove gear cover thrust screw assemblies from gear cover (screwdriver and $^{13}/_{16}$-in. open-end wrench) (fig. 144).

(c) Drive gear cover thrust screw fiber plug from gear cover thrust screw (hammer and drift) (fig. 146). Repeat operation to remove other thrust screw.

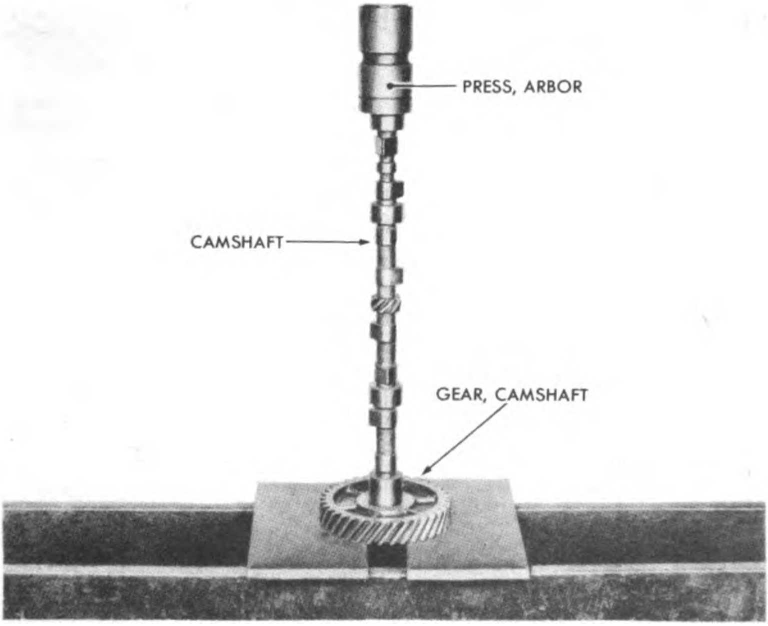
(d) Tap oil pan and crankshaft seal from gear cover (drift and hammer) (fig. 146).

(e) Lift oil pan and crankshaft seal from gear cover (fig. 146).

(10) REMOVE OIL PUMP (par. 160).

(11) REMOVE CAMSHAFT AND IDLER GEAR.

(a) Pull all eight valve tappets away from camshaft. Lift camshaft gear and attached camshaft from cylinder block. Lift camshaft thrust washer from cylinder block (fig. 147).



RA PD 43951

Figure 148 — Pressing Camshaft Gear Onto Camshaft

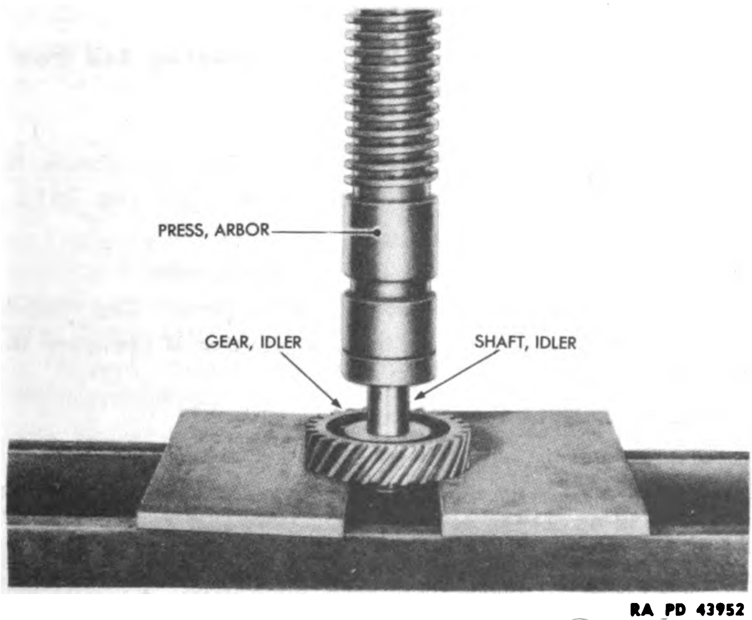


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Figure 149 — Pressing Idler Gear from Idler Shaft

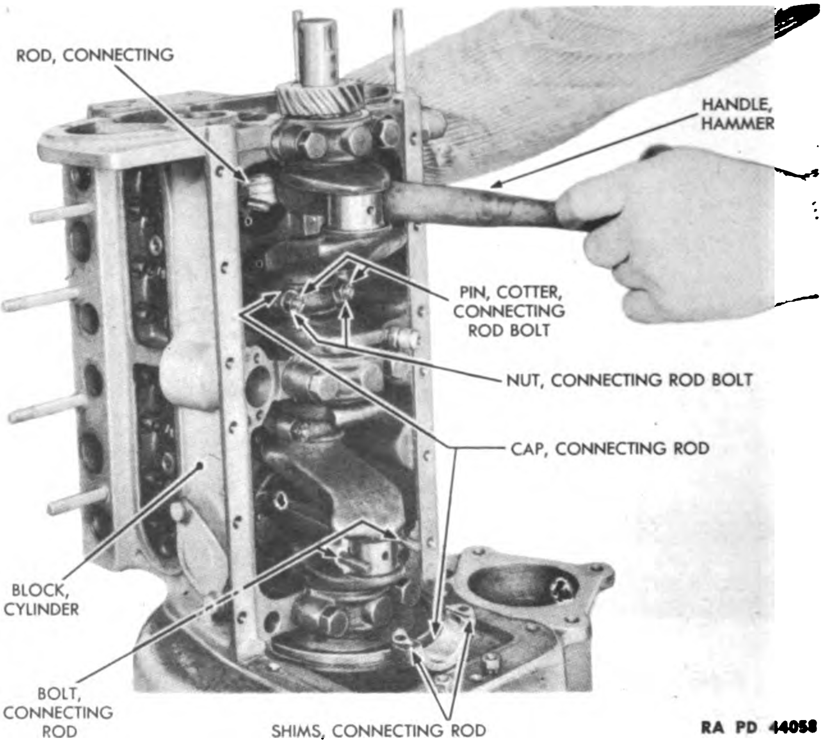

Figure 150 — Pushing Piston and Connecting Rod from Cylinder Block

(b) Lift idler gear and attached idler shaft from cylinder block. Pick idler shaft thrust washer from cylinder block (fig. 147).

(12) Disassemble Camshaft.

HAMMER, soft PRESS, arbor

Press camshaft gear from camshaft (arbor press). Tap (soft hammer) camshaft gear key from camshaft (reverse of operation shown in fig. 148).

(13) Disassemble Idler Shaft.

PRESS, arbor

Press idler gear from idler shaft (arbor press) (reverse of operation shown in fig. 149).

(14) Remove Pistons and Connecting Rods.

HAMMER WRENCH, socket, ½-in.
PLIERS, thin-nosed

ENGINE REMOVAL AND DISASSEMBLY

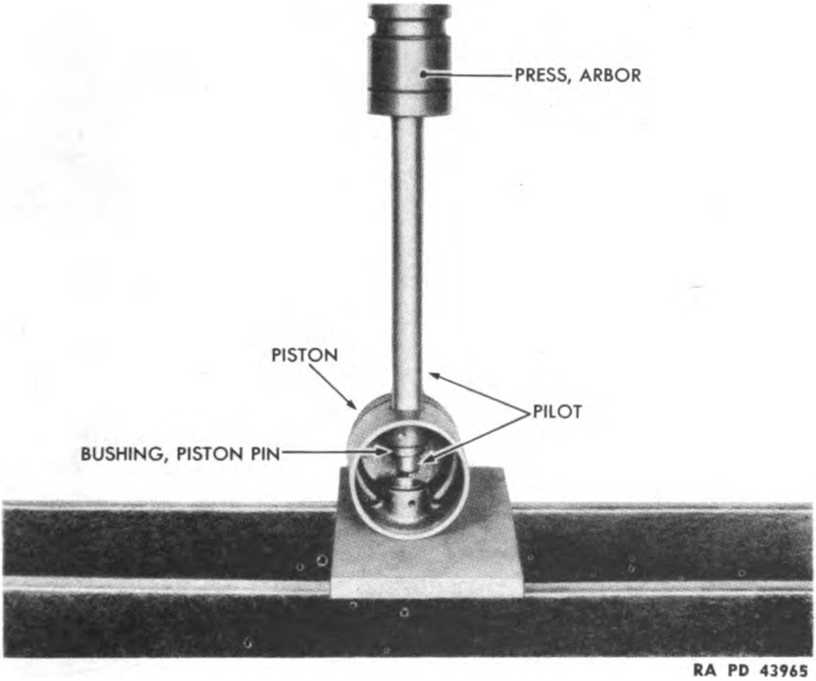

Figure 151 — Pressing Piston Pin Bushing from Piston

(a) Remove connecting rod bolt cotter pins from connecting rod (thin-nosed pliers) (fig. 150).

(b) Remove connecting rod bolt nuts (½-in. socket wrench) (fig. 150).

(c) Lift connecting rod cap and shims from connecting rod bolts (fig. 150).

(d) Place a hammer handle against end of connecting rod (*not against bearing surface*) and push connecting rod and piston out through top of cylinder block (fig. 150). NOTE: If engine is equipped with replacement pistons, be sure both rod and cap are marked with cylinder number on camshaft side of rod and cap.

(e) Repeat substeps *(a)* through *(d)* above, to remove each of the three remaining pistons and connecting rods.

(15) DISASSEMBLE PISTON AND CONNECTING ROD.

DRIFT, soft	PLIERS, thin-nosed
EXPANDER, piston ring	PRESS, arbor
HAMMER	WRENCH, socket, 7/16-in.

(a) Remove two compression and one oil piston ring from piston (piston ring expander).

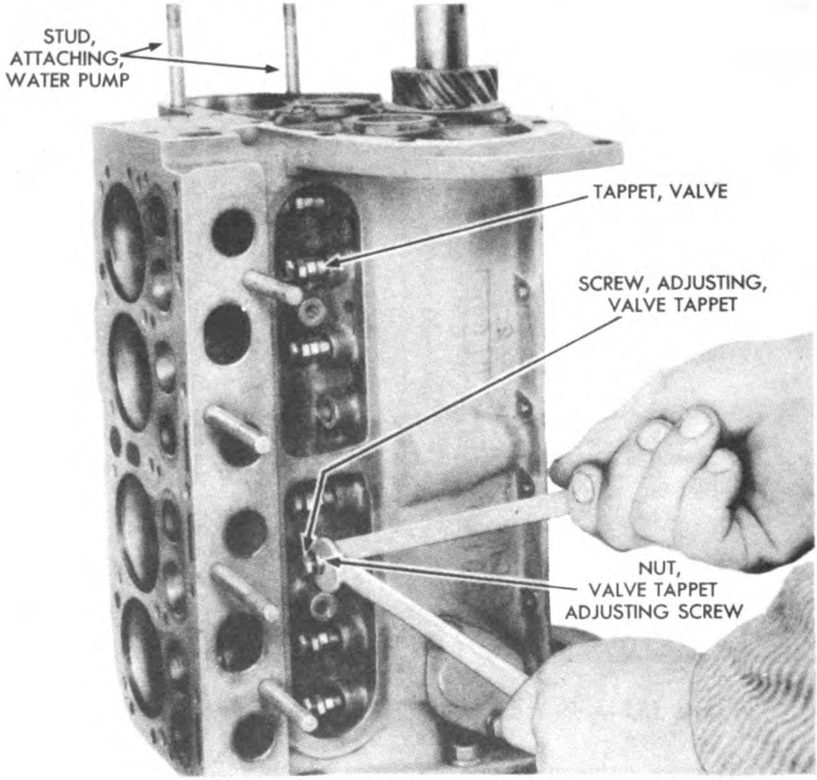

Figure 152 — Removing Valve Tappet

(b) Remove lock wire which locks the connecting rod piston pin lock screw (thin-nosed pliers).

(c) Remove connecting rod piston pin lock screw from connecting rod ($\frac{7}{16}$-in. socket wrench).

(d) Tap piston pin from the piston and connecting rod (soft drift and hammer). Lift piston from connecting rod.

(e) Press piston pin bushings from piston (arbor press) (fig. 151).

(f) Repeat substeps *(a)* through *(e)* above, to disassemble each of remaining three piston and connecting rod assemblies.

(16) REMOVE VALVE TAPPETS.

WRENCH, open-end, $\frac{3}{8}$-in. WRENCH, open-end, $\frac{7}{16}$-in.

(a) Using a $\frac{3}{8}$-inch open-end wrench to hold tappet, remove loosened valve tappet adjusting screw nut ($\frac{7}{16}$-in. open-end wrench). Remove valve tappet adjusting screw from valve tappet ($\frac{7}{16}$-in. open-end wrench) (fig. 152).

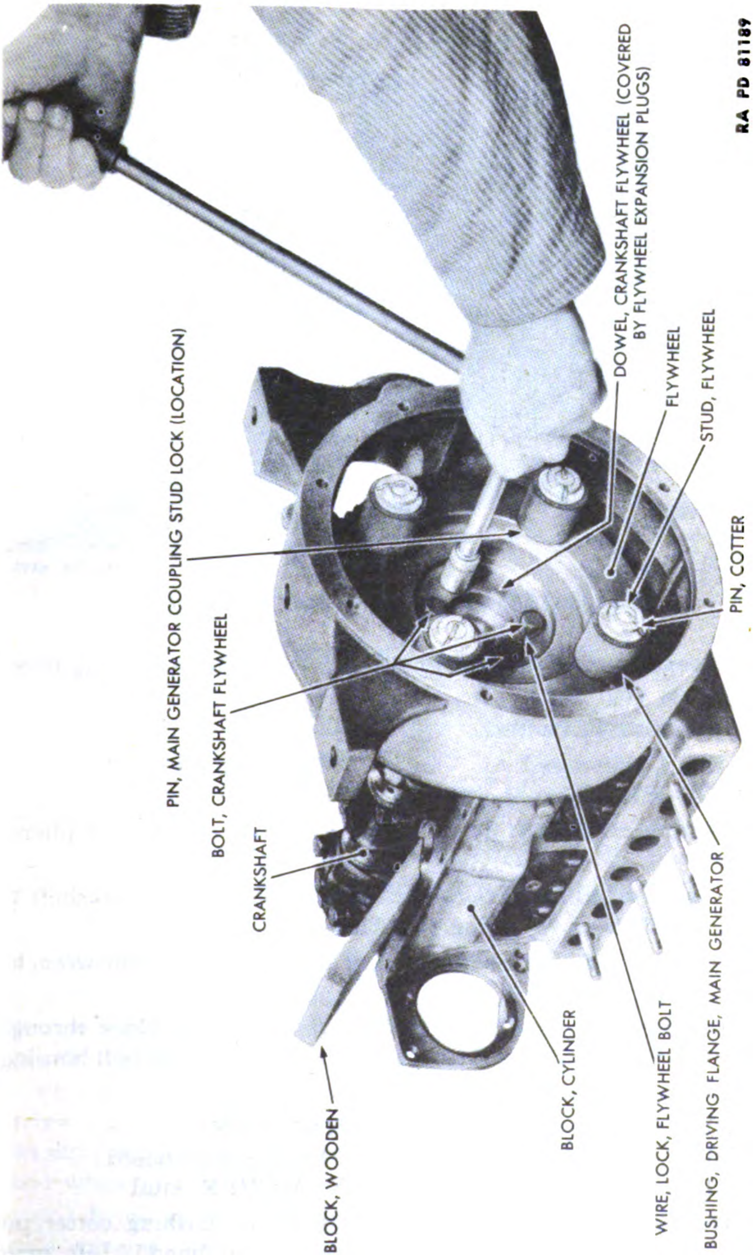

Figure 153 — Removing Flywheel

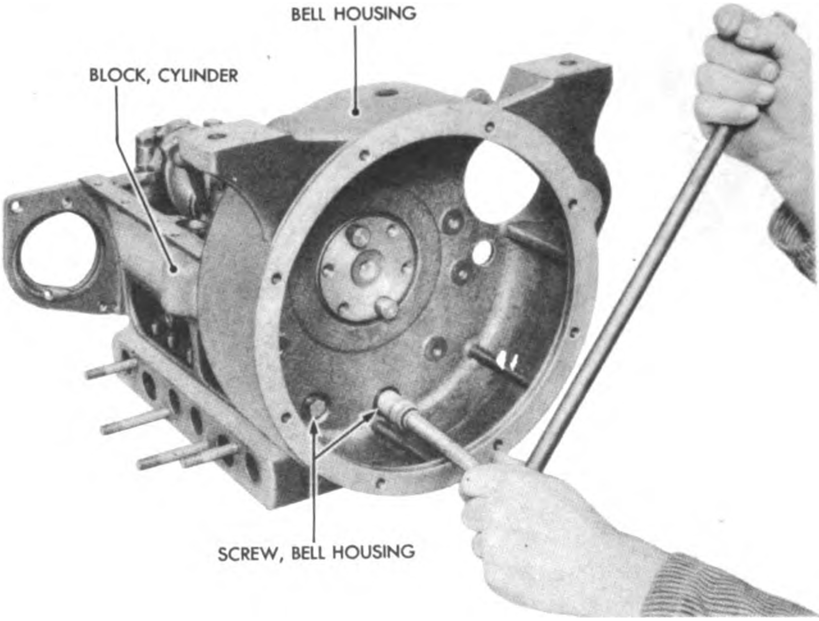

Figure 154 — Removing Bell Housing

(b) Repeat substep *(a)* above, to remove each of remaining seven valve tappets (fig. 152).

(17) REMOVE FLYWHEEL.

PLIERS, thin-nosed
WOOD BLOCK
WRENCH, socket, 5/8-in.

(a) Remove crankshaft flywheel bolt lock wire (thin-nosed pliers) (fig. 153).

(b) Place a wood block between cylinder block and crankshaft to keep crankshaft from revolving (fig. 153).

(c) Remove four crankshaft flywheel bolts (5/8-in. socket wrench) (fig. 153).

(d) Tap flywheel loose from crankshaft with wood block through starting motor opening in bell housing. Lift flywheel from bell housing.

(18) DISASSEMBLE FLYWHEEL ASSEMBLY.

DRIFT
DRIFT, soft
DRILL, electric
HAMMER
PLIERS, thin-nosed
REMOVER, stud

(a) Remove a main generator driving flange bushing cotter pin (thin-nosed pliers) and fiber retaining nut (by hand). Lift main generator driving flange bushing from stud. Drill stud lock pin from flywheel and stud (electric drill). Remove stud from flywheel (stud

ENGINE REMOVAL AND DISASSEMBLY

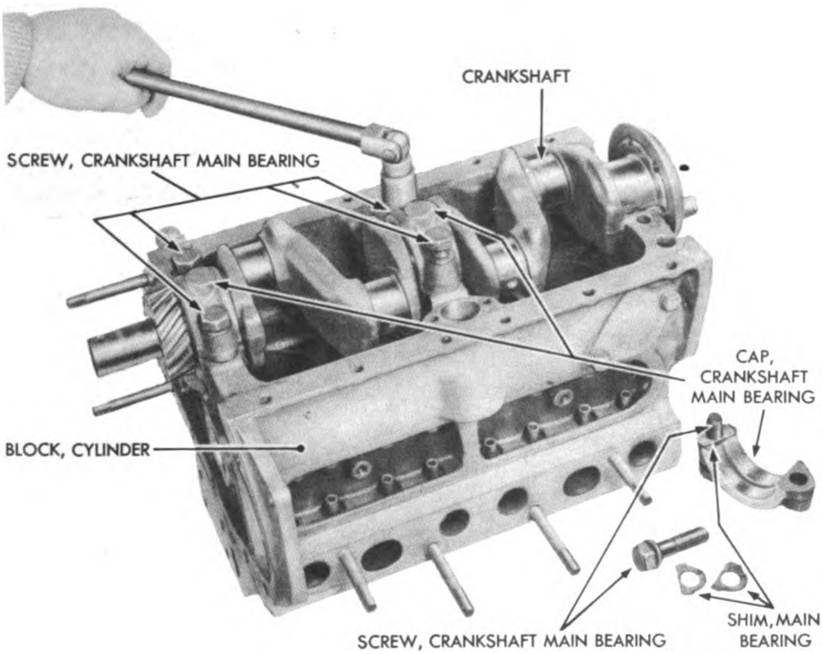

Figure 155 — Removing Crankshaft

remover). Repeat operation to remove each of three remaining main generator driving flange bushings.

(b) Tap the two flywheel expansion plugs from flywheel (drift and hammer).

(c) Drive ring gear from flywheel (soft drift and hammer). CAUTION: Do not hold drift against teeth of ring gear.

(19) REMOVE BELL HOUSING.

WRENCH, open-end, $^9/_{16}$-in. WRENCH, socket, $^9/_{16}$-in.

(a) Remove, from inside bell housing, bell housing screws and lock washers which secure bell housing to cylinder block ($^9/_{16}$-in. socket wrench) (fig. 154).

(b) From accessory side of cylinder block, remove bell housing screw and lock washer, and thin head bell housing screw and lock washer, which secure bell housing to cylinder block ($^9/_{16}$-in. open-end wrench) (fig. 134).

(c) From valve tappet side of cylinder block, remove bell housing stud nut and lock washer which secure bell housing to cylinder block ($^9/_{16}$-in. open-end wrench) (fig. 141).

(d) Lift bell housing and gasket from cylinder block (fig. 154).

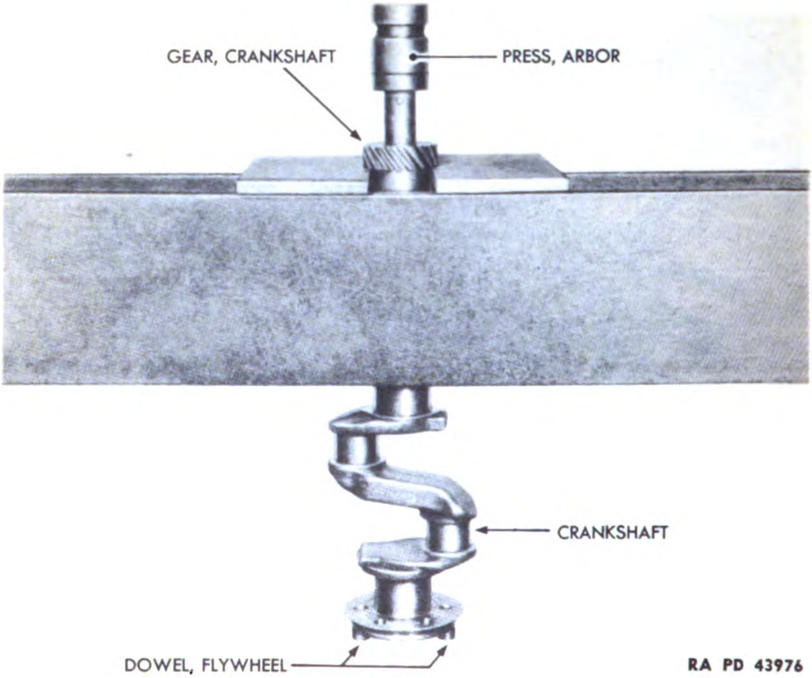

Figure 156 — Pressing Crankshaft Gear from Crankshaft

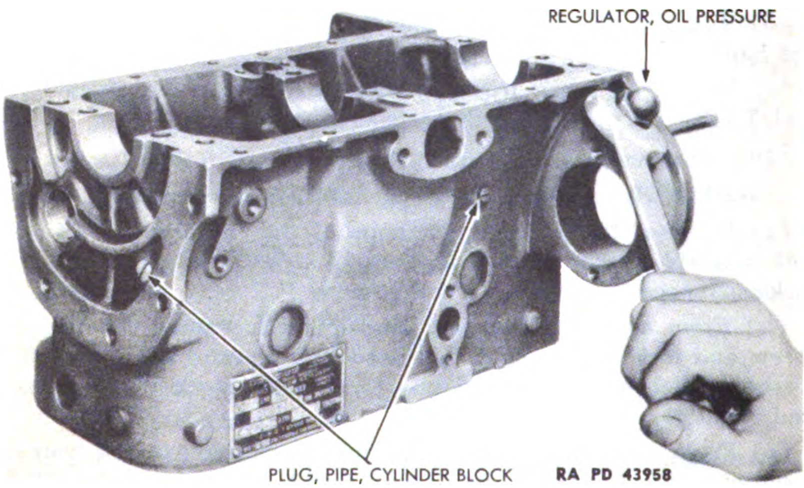

Figure 157 — Removing Oil Pressure Regulator

ENGINE REMOVAL AND DISASSEMBLY

(20) Remove Crankshaft.

WRENCH, socket, 3/4-in.

(a) Remove the crankshaft main bearing screws and lock washers which secure each of the three main bearing caps to cylinder block (3/4-in. socket wrench) (fig. 155).

(b) Lift main bearing caps, six screws, and shims from cylinder block (fig. 155). Put shims in envelopes and mark positions from which taken, to facilitate assembly.

(c) Lift crankshaft from cylinder block (fig. 155).

(d) Lift main bearings from cylinder block (fig. 155), and scratch identifying marks on backs of bearings so they can be assembled in same position.

(21) Disassemble Crankshaft.

DRIFT PRESS, arbor
HAMMER

(a) Press crankshaft gear from crankshaft (arbor press) (fig. 156). CAUTION: Do not perform this step unless gear needs replacing.

(b) Drive the two flywheel dowels from rear end of crankshaft (drift and hammer) (fig. 156).

(22) Remove Oil Pressure Regulator and Cylinder Pipe Plugs.

SCREWDRIVER

(a) Remove oil pressure regulator (par. 161) (fig. 157).

(b) Remove cylinder block pipe plugs at each end of oil gallery in cylinder block (screwdriver). Also remove cylinder block pipe plug on accessory side of cylinder block.

Section XV

DISASSEMBLED ENGINE INSPECTION

117. ENGINE COMPONENT CLEANING.

a. Equipment.

BRUSH, power driven rotary wire
BRUSH, wire
COMPRESSED AIR
KNIFE, putty
SOLVENT, dry-cleaning
TOOL, carbon removing

b. Procedure.

(1) Clean all metal parts in SOLVENT, dry-cleaning, and dry with compressed air.

(2) Clean carbon deposits on valves with a power-driven rotary wire brush.

(3) Clean carbon from piston ring grooves in piston with a carbon removing tool, or with a segment of a broken piston ring.

(4) Scrape carbon from tops of pistons, from cylinder head (fig. 158), and from cylinder block with a carbon removing tool.

(5) Blow compressed air through oil passages in cylinder block and crankshaft. Remove any obstructions with SOLVENT, dry-cleaning, and a wire brush.

(6) Scrape all gaskets from metal parts with a putty knife.

(7) Remove sealing compound with SOLVENT, dry-cleaning, and a wire brush.

(8) Blow compressed air through water jacket of cylinder head and cylinder block.

118. CYLINDER BLOCK AND CYLINDER HEAD INSPECTION.

a. Equipment.

GAGE, feeler
INDICATOR, dial

b. Procedure.

(1) INSPECT CYLINDER BLOCK.

GAGE, feeler
INDICATOR, dial

DISASSEMBLED ENGINE INSPECTION

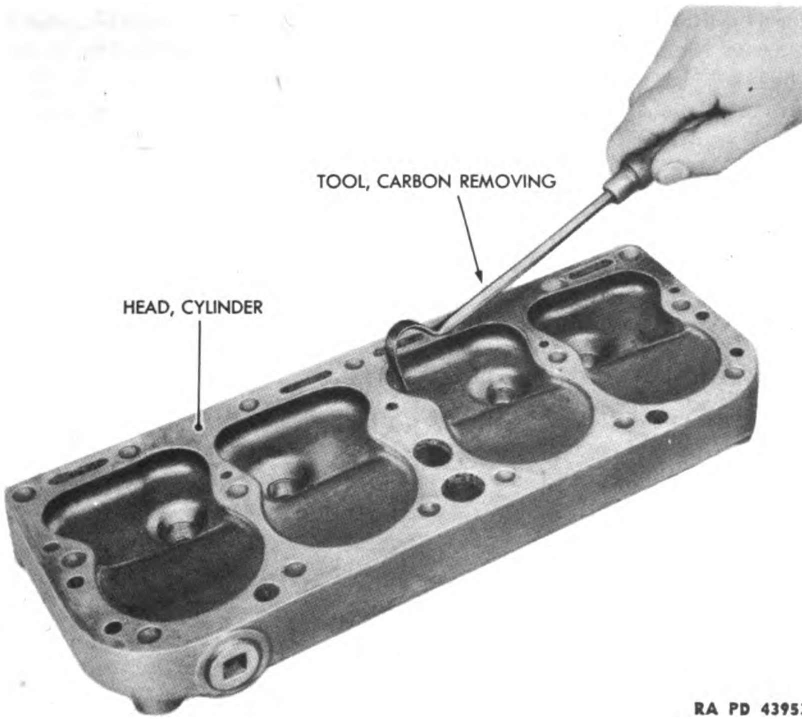

Figure 158 — Scraping Carbon from Cylinder Head

(a) Inspect the four manifold studs and two water pump and gear cover studs for broken or damaged threads.

(b) Inspect cylinder block for cracks, especially between valve seats and cylinders.

(c) Run a dial indicator up and down and around each cylinder. Note if readings vary as much as 0.003 to 0.005 inch. This indicates taper or out-of-round.

(d) Insert valve stem into valve guide and move valve back and forth sidewise. Since a 0.0015-inch clearance is maximum allowable clearance, more than a barely perceptible movement indicates worn valve guides and valve stems. If loose, repeat check using a new valve. If new valve stem is loose, guide is worn. NOTE: Be sure to check each valve guide with the valve that goes in that particular guide.

(e) Slide idler shaft into idler shaft bearing. More than a barely perceptible side play (0.0015 in.) indicates a worn bearing.

(f) Slide camshaft into camshaft bearings. Measure clearance between bearing and journal with a feeler gage. Excess of a 0.0025-inch clearance indicates worn camshaft bearings.

(g) Slide each valve tappet, one at a time, into its guide hole in cylinder block, and test side play by attempting to move the tappet sidewise. Since maximum clearance is 0.001 inch, more than a barely perceptible side play indicates worn cylinder block or tappets. If loose, repeat check using a new tappet. If new tappet is loose, cylinder block is worn.

(h) Inspect all tapped threads for damage.

(i) Inspect all cylinder expansion plugs for looseness or leakage. Leakage will be indicated if cylinder block is discolored around plug.

(j) Examine valve seats to see if they are eccentric, pitted, or burned.

(2) INSPECT CYLINDER HEAD.

(a) Examine cylinder head for cracks.

(b) Examine machined face of cylinder heads for nicks or scratches serious enough to allow water leakage or compression loss.

(c) Examine threads on cylinder head screws and studs for damage.

(d) Examine threads in holes tapped for spark plugs.

119. VALVES AND VALVE OPERATING MECHANISM INSPECTION.

a. Inspect Valves.

(1) Examine valve faces to see if they are warped, pitted, cracked, or burned.

(2) Test wear of valve stems by inserting them in valve guides. Presence of side play indicates wear.

(3) Examine valve springs, spring seats, and spring seat pins for wear or breakage.

b. Inspect Valve Tappets.

(1) Examine faces and stems of valve tappets for score marks or breakage.

(2) Examine valve tappet adjusting screws and nuts to see if they are broken or have damaged threads.

(3) Examine threads in valve tappet stem. NOTE: Valve tappets were tested for wear in paragraph 118 b (1) *(g)*.

c. Inspect Camshaft.

(1) Examine camshaft gear and oil pump drive gear for broken or worn teeth.

(2) Examine cams and journals for score marks.

(3) Examine thrust washer to see if it is worn or scored.

DISASSEMBLED ENGINE INSPECTION

120. PISTON AND CONNECTING ROD INSPECTION.

a. Equipment.

FIXTURE, connecting rod alining
GAGE, feeler
MICROMETER

b. Procedure.

(1) Examine connecting rod bearing for score marks, or broken, chipped, or burned babbitt.

(2) Examine threads on connecting rod cap bolts, nuts, and connecting rod piston pin lock screw for damage.

(3) Place assembled connecting rod and piston on a connecting rod alining fixture, and check for bend, twist, and offset (par. 126 b (5)).

(4) Test fit of piston pin in piston pin bushings by attempting to rock the assembled connecting rod sidewise in the piston. Correct clearance is 0.0005 inch. No side play should be noticeable. Presence of rocking motion indicates worn bushings or pin, or both. NOTE: Do not confuse sidewise motion of pin in bushing for rocking motion.

(5) Examine piston for score marks.

(6) Using a 2- to 3-inch micrometer, measure distance across skirt of piston at intervals around piston. If measurements vary, piston is out-of-round.

(7) Inspect piston rings for breakage. Using a feeler gage, measure clearance of rings in piston ring groove. A maximum of 0.0025 inch is permissible in an unworn ring. Place piston rings, one at a time, in running position in cylinder. Measure clearance at end gap with a feeler gage. Safe maximum end gap is 0.020 inch.

121. ACCESSORY DRIVE INSPECTION.

a. Equipment.

GAGE, feeler

b. Procedure.

(1) Inspect accessory drive gear and distributor drive gear for broken or worn teeth.

(2) Inspect accessory drive shaft and thrust washer for score marks or wear.

(3) Slide accessory drive shaft into accessory drive bushing and test side play. A 0.002-inch maximum is permissible (feeler gage). More than a barely perceptible side play indicates a worn bushing.

(4) Examine accessory drive oil retainer for breakage. Tap retainer into position in housing to test fit. If loose, retainer is worn. NOTE: Accessory drive cork washer should be replaced each time accessory drive is disassembled.

(5) Examine accessory drive housing for breakage.

122. CRANKSHAFT AND MAIN BEARINGS, INSPECTION.

a. Equipment.

BLOCK, V— (2)
BRUSH, wire
INDICATOR, dial
LATHE
MICROMETER

b. Procedure.

(1) INSPECT CRANKSHAFT.

BLOCK, V— (2)
BRUSH, wire
INDICATOR, dial
LATHE
MICROMETER

(a) Examine teeth of crankshaft gear to see if they are worn or broken.

(b) Inspect threads tapped in flywheel end of crankshaft for damage.

(c) Examine bearing journals for scoring or burning.

(d) Run a wire brush through the four oil passages to be sure that they are free of obstruction.

(e) Measure diameter of each bearing journal at intervals with a micrometer. If size of any journal varies more than 0.003 inch, journal is out-of-round.

(f) Revolve crankshaft in a lathe or V-blocks. Place a dial indicator against center main bearing journal. If reading is not constant as crankshaft is rotated, crankshaft is bent. Maximum allowable run-out is 0.002 inch. NOTE: If step *(e)* above indicates out-of-round center main bearing journal, this test cannot be made until out-of-round condition is corrected.

(2) INSPECT CRANKSHAFT MAIN BEARINGS.

(a) Examine bearing in cap and insert for chipped, broken, burned, or scored babbitt.

(b) Examine main bearing screws and lock washers to see if they are broken or have damaged threads.

123. REMAINING ENGINE COMPONENT INSPECTION.

a. Inspect Fan Drive Pulley. Inspect fan drive pulley pin and key for breakage.

b. Inspect Engine and Radiator Support Brackets. Inspect engine and radiator support brackets to see if they are broken or bent.

c. Inspect Oil Pan.

(1) Examine oil pan for dents or cracks.

(2) Examine oil screen for carbon deposits.

(3) Examine oil pan screws and oil pan screen screws to see if they are broken or have damaged threads.

(4) Examine threads on oil drain pipe assembly and in oil pan drain pipe opening.

d. Inspect Gear Cover.

(1) Inspect gear cover for cracks.

(2) Measure distance each thrust screw fiber plug projects from thrust screw. If less than three-sixteenths inch, plug is worn out. Also note whether plug is broken.

(3) Examine threads on all screws and nuts for damage.

e. Inspect Idler Shaft Assembly.

(1) Examine teeth of idler gear for breakage or wear.

(2) Examine idler shaft for score marks.

(3) Examine thrust washer to see if it is worn or scored.

f. Inspect Flywheel.

(1) Examine flywheel for cracks.

(2) Test fit of dowel pins in dowel pin holes. They should be a drive fit. If pins go in easily, test fit with a new pin. If new pin fits easily, dowel pin hole is too large.

(3) Examine threads in the four main generator driving flange bushing stud holes for damage.

(4) Examine main generator driving flange bushings for wear or breakage.

(5) Inspect teeth of ring gear for breakage or wear.

g. Inspect Bell Housing.

(1) Examine bell housing for cracks.

(2) Inspect threads in all tapped holes for damage.

(3) Examine all cap screws, studs, nuts, and lock washers for breakage or damaged threads.

h. Inspect Oil Pressure Regulator and Cylinder Pipe Plugs.

(1) Examine oil pressure regulating piston, spring, adjusting screw, and nut for breakage and/or damaged threads.

(2) Examine oil pressure regulating piston to see if it is scored.

(3) Examine threads on cylinder pipe plugs for damage.

Section XVI

ENGINE MAINTENANCE AND REPAIR

Paragraph

124. CYLINDER BLOCK AND CYLINDER HEAD REPAIRS.

a. Equipment.

BAR, boring	REAMER
DIE, thread	REMOVER, stud
DRILL, electric	SCALE
FILE, mill	SOFT BLOCK
GAGE, feeler	STRAIGHTEDGE
HAMMER	TAP, thread
HONE, cylinder	TOOL, carbon removing
MACHINE, milling	TOOL, cutting
PILOT	VARNISH, shellac
PILOT, valve guide	WELDING EQUIPMENT
PUNCH, sharp	WRENCH, open-end, $^{9}/_{16}$-in.

b. Procedure.

(1) REMOVE BROKEN STUDS.

DRILL, electric	REMOVER, stud
HAMMER	

(a) Remove studs broken above the surface of the cylinder block or cylinder head with a stud remover.

(b) Remove studs broken flush with cylinder block or below surface of cylinder block as follows:

1. Using an electric drill with a bit about one-half the diameter of the stud, drill a hole the length of stud through its center.

2. Tap a stud removing tool into the drilled hole (hammer).

3. Screw the stud from the cylinder block.

(2) WELDING CRACKED CYLINDER BLOCK.

WELDING EQUIPMENT

If possible, replace cracked cylinder blocks. If crack is not on a cylinder wall or machined surface, cylinder block may be temporarily repaired by welding.

(3) REBORING CYLINDER BLOCK.

BAR, boring	TOOL, cutting
FILE, mill	WRENCH, open-end, $^{9}/_{16}$-in.
HONE, cylinder	

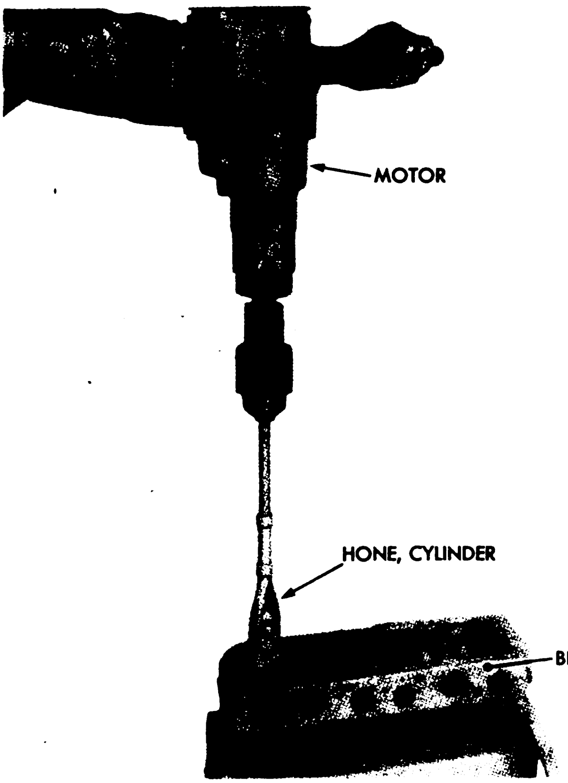

Figure 159 — Honing Cylinders

(a) If inspection reveals tapered, out-of-round, or scored cylinders, rebore cylinders with a boring bar. Directions for operation are furnished with each make of boring bar. General steps in reboring cylinders follow:

1. Machined surface of top of cylinder block must be cleaned by taking a light cut with a mill file.

2. Place boring bar in position over cylinder. Secure it to the cylinder block with cylinder head cap screws ($\frac{9}{16}$-in. open-end wrench).

3. Center bar over cylinder to be rebored, and adjust the cutting tool to the size the cylinder is to be cut. This depends upon the size of the oversize piston to be fitted (par. 126 **b** (4)).

4. Start boring bar motor and engage the cutting tool.

5. Stop boring bar motor as soon as the cutting tool has cut entire length of cylinder bore.

6. Return cutting tool to top of cylinder block and detach boring bar from cylinder block.

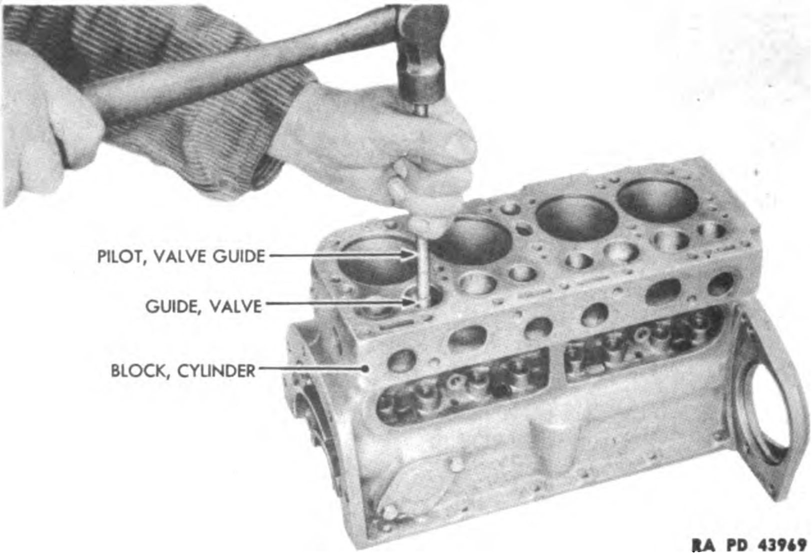

Figure 160 — Installing Valve Guide

7. Repeat substeps *2* through *6* above to rebore each of the three remaining cylinders.

(b) Hone each cylinder (step (4) below) to remove any tool marks from cylinder wall.

(c) Fit oversize pistons to cylinder (par. 126 b (4)).

(4) HONING CYLINDERS (fig. 159).

HONE, cylinder

(a) Cylinders only slightly tapered, out-of-round, or scored (less than 0.005 inch) can be corrected by honing without first reboring. Honing is a slower method. Cylinders are polished by honing after reboring (step (3) above).

(b) Two types of hones, wet and dry, are in common use. Each consists of a grinding tool which is revolved in the cylinder with an electric motor. In a wet hone, cylinder wall is lubricated with diesel fuel during the operation. No lubrication is provided for a dry hone, but vacuum dust collecting equipment is set up under cylinder block.

(c) Refer to manufacturer's directions to use the particular hone available for use. Following are general directions which apply to most hones:

1. Set up dirt collecting vacuum equipment under cylinder block if a dry hone is used. Set up lubricating equipment on top of cylinder block if hone is the wet type.

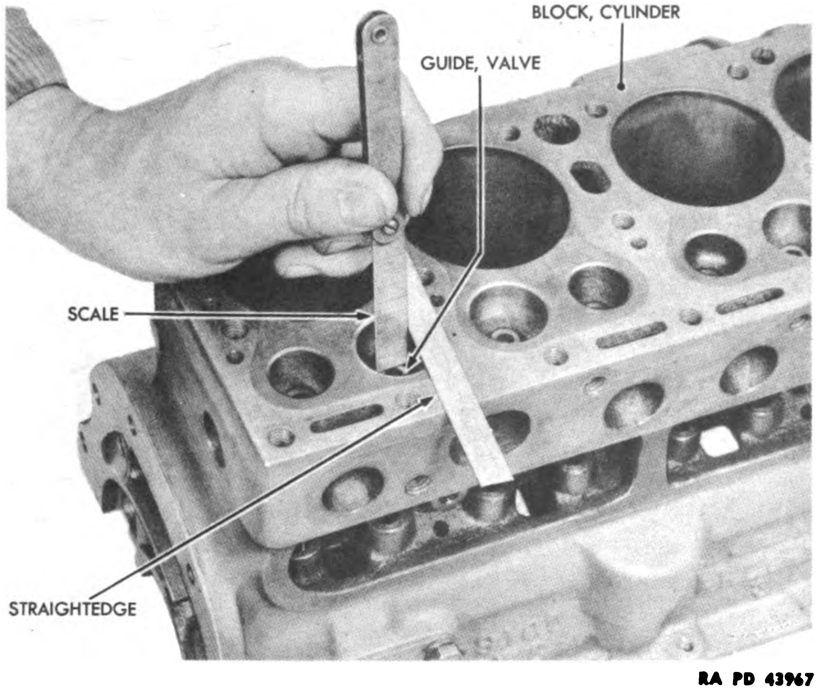

Figure 161 — Measuring Position of Installed Valve Guide

2. Place hone in position in cylinder, and adjust rough cutting stones to cylinder size.

3. Start hone motor and move hone slowly up and down as it revolves in the cylinder. Hone high spots first (determined in inspection (par. 118 **b** (1) *(c)*) with a dial indicator). Then run hone up and down full length of cylinder bore until size of oversize piston to be fitted (par. 126) is obtained (fig. 159).

4. Remove hone and install polishing stones. Hone until piston fits with proper clearance (par. 126).

5. Repeat substeps *1* through *4* above to hone each of remaining three cylinders.

(5) Replacing Worn Valve Guides (fig. 160).

HAMMER	SCALE
PILOT, valve guide	STRAIGHTEDGE

(a) Place valve guide pilot in top of valve guide to be removed.

(b) Drive valve guide down until it falls from cylinder block (hammer).

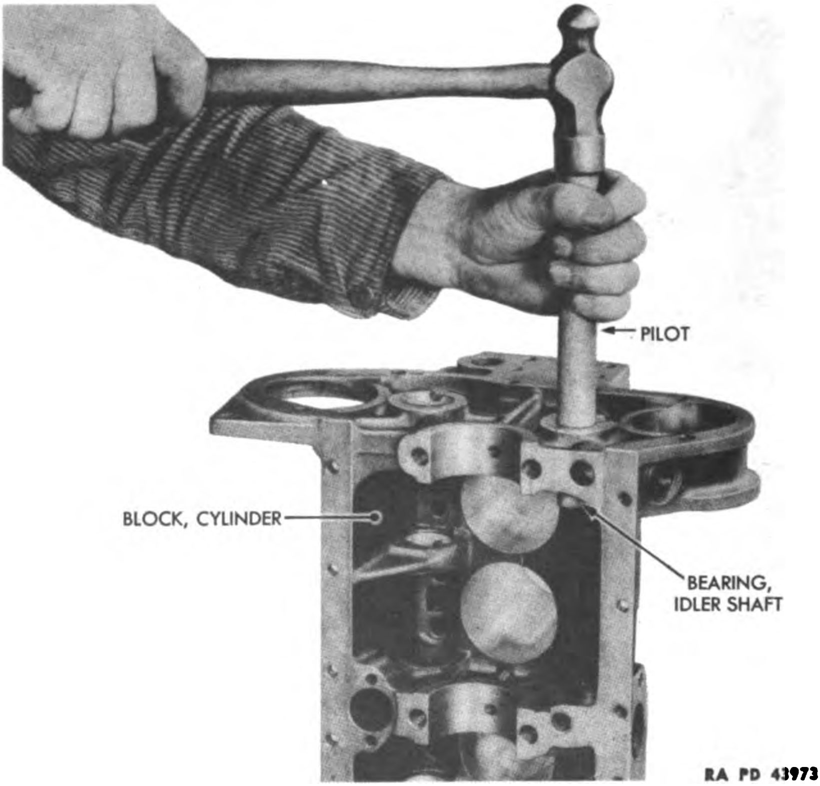

Figure 162 — Removing Idler Shaft Bearing

(c) Place new valve guide in position on top of cylinder block. Insert valve guide pilot in top of valve guide.

(d) Drive valve guide into block until its top is $1\frac{9}{32}$ inch from the machined surface of cylinder block (hammer, scale, and straightedge) (fig. 161).

(6) Replacing Worn Idler Shaft Bearing.

GAGE, feeler	PILOT
HAMMER	REAMER

(a) Using a pilot with an outside diameter of $3\frac{1}{32}$ inch and an inside diameter of $2\frac{7}{32}$ inch, drive idler shaft bearing out of cylinder block (hammer) (fig. 162).

(b) Line up oil channel in cylinder block with semicircular slot in end of bearing. Drive bearing into place in cylinder block (end without slot first) (pilot and hammer) (fig. 162).

(c) Insert idler gear in installed bearing, and measure clearance with a feeler gage. If less than 0.001 inch, ream bearing (fig. 163)

until a 0.001-inch clearance is obtained (reamer). If over 0.0015 inch, replace idler shaft, and ream bearing to a clearance of from 0.001 to 0.0015 inch for new shaft (fig. 163).

(7) REPLACING WORN CAMSHAFT BEARINGS.

GAGE, feeler	PILOT
HAMMER	REAMER

(a) Using a pilot with an outside diameter of $1\frac{11}{32}$ inch and an inside diameter of $1\frac{7}{32}$ inch, drive the four camshaft bearings out of cylinder block (hammer) (fig. 162). NOTE: These bearings have no collar and can be driven either way.

(b) Install new camshaft bearings, one at a time (pilot and hammer). Be sure to line up oilholes in bearing with oilholes in cylinder block.

(c) Examine installed bearings and remove burs (reamer). NOTE: These bearings are reamed to proper size and need no further reaming.

(d) Insert camshaft in installed bearings and measure clearance (feeler gage). If it exceeds 0.0025 inch, replace camshaft.

(8) REPAIRING WORN VALVE TAPPET GUIDE HOLE.

REAMER

If valve tappet guide holes are worn, oversize, or scored, ream them to 0.005 inch oversize. Replace valve tappets with 0.005-inch oversize valve tappet.

(9) REPAIRING DAMAGED THREADS.

DRILL, electric	TAP, thread
REAMER	WELDING EQUIPMENT

(a) Burred threads are corrected by running a thread tap through them.

(b) Stripped threads are corrected by one of the three following methods:

1. Cut threads oversize (thread tap). Replace stud or cap screw with an oversize part. Ream out stud or cap screw hole in attaching part (reamer).

2. Using welding equipment, fill stud hole. Drill hole to proper size (electric drill). Cut new threads with thread tap.

(10) LEAKING CYLINDER CUP PLUGS.

HAMMER	TOOL, carbon removing
PUNCH, sharp	VARNISH, shellac
SOFT BLOCK	

Remove loose or defective cylinder cup plugs by driving a sharp punch through them and prying them out (hammer). Clean cylinder block by scraping (carbon removing tool). Coat the new plug with

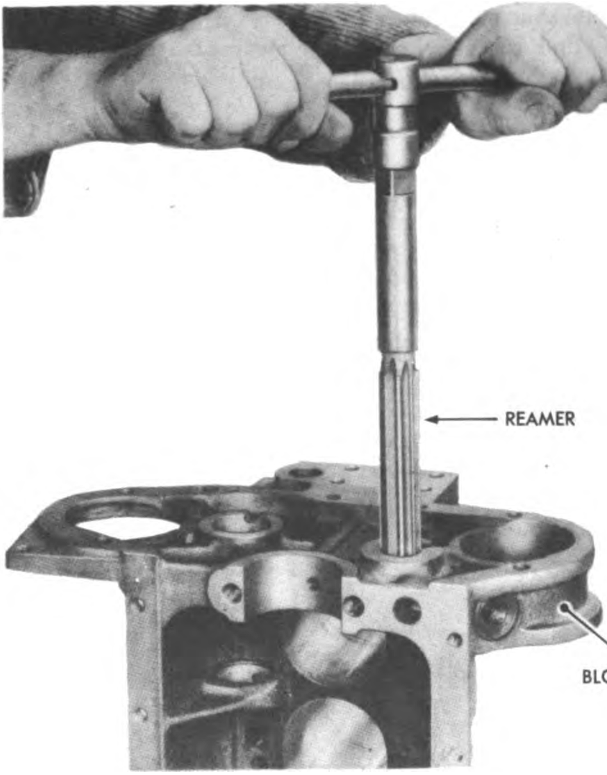

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Figure 163 — Reaming Idler Shaft Bearing

VARNISH, shellac, and drive it to seat in cylinder block (soft block and hammer).

(11) Reseating Valves (fig. 164).

REAMER

(a) If valve seats are pitted, burned, scored, or off-center, reseat valve as follows:

1. Place a 30-degree finishing reamer (1⅛ inch for exhaust valve and 1⅜ inch for intake valve) in valve guide. Bear down on reamer so that reamer presses against valve seat in cylinder block.

2. Turn reamer clockwise.

3. Remove reamer. Examine valve seat. Repeat substeps *1* and *2* above until valve seat shows a clean cut all the way around.

4. Reface valves (par. 125 **b** (2)), lap valves (par. 125 **b** (3)), and test fit of valve in valve seat (par. 125 **b** (4)).

(12) Repairing Cracked Cylinder Head.

WELDING EQUIPMENT

Replace cylinder head if cracked. A temporary repair for a cylinder

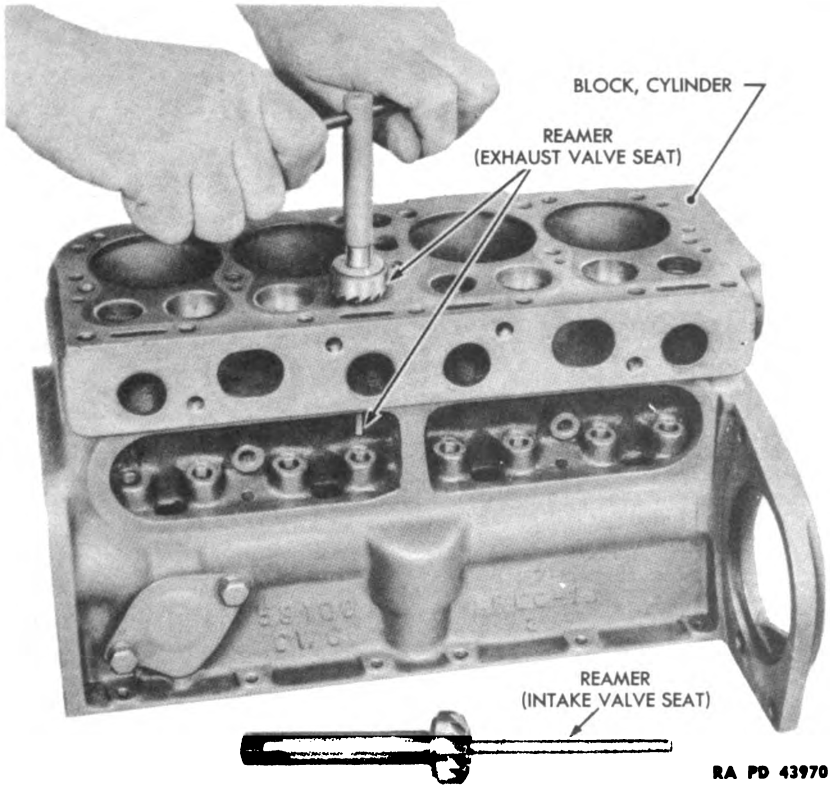

Figure 164 — Reseating Valves

head cracked outside can be made by welding.

(13) SCRATCHED OR NICKED MACHINED FACE OF CYLINDER HEAD.

MACHINE, milling

If the machined face of the cylinder head has nicks or scratches serious enough to allow water leakage or compression loss, replace cylinder head. If no new head is available, take a light cut from machined surface of head on a milling machine. If a heavy cut is necessary, use two cylinder head gaskets on assembly to prevent too great a change in engine compression.

(14) REPLACING DAMAGED CYLINDER HEAD SCREWS AND STUDS.

DIE, thread

Replace broken cylinder head screws and studs, and repair those having only damaged threads.

(15) REPAIRING DAMAGED THREADS IN SPARK PLUG HOLES.

TAP, thread

Run a thread tap through threads if burred. Replace cylinder head if threads are stripped.

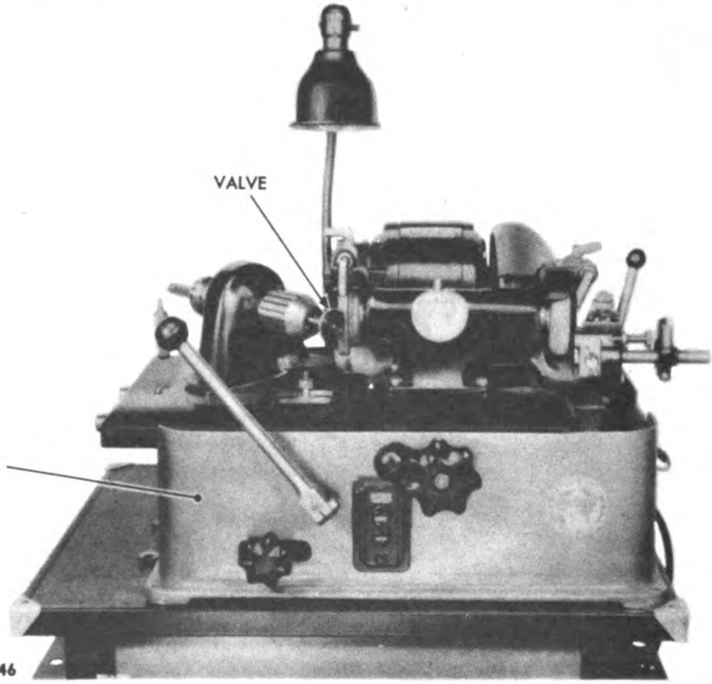

Figure 165 — Refacing Valve

125. VALVES AND VALVE OPERATING MECHANISM REPAIRS.

a. Equipment.

COMPOUND, valve grinding (fine)
HONE
PENCIL
PRESS, arbor
REFACER, valve
SCREWDRIVER
SOLVENT, dry-cleaning
SPRING, coil
STONE, honing

b. Procedure.

(1) GENERAL.

Replace warped, cracked, burned, or badly pitted valves. Replace valves with worn stems. Replace worn or damaged valve springs, spring seats, and spring seat pins.

(2) REFACING VALVES.

REFACER, valve

(a) Reface slightly pitted or slightly scored valves (valve refacer). Reface all undamaged valves after 300 hours service (fig. 165).

(b) Set valve face angle at 30 degrees. Reface one valve and test fit on the valve seat (step (4) below). Make any necessary angle

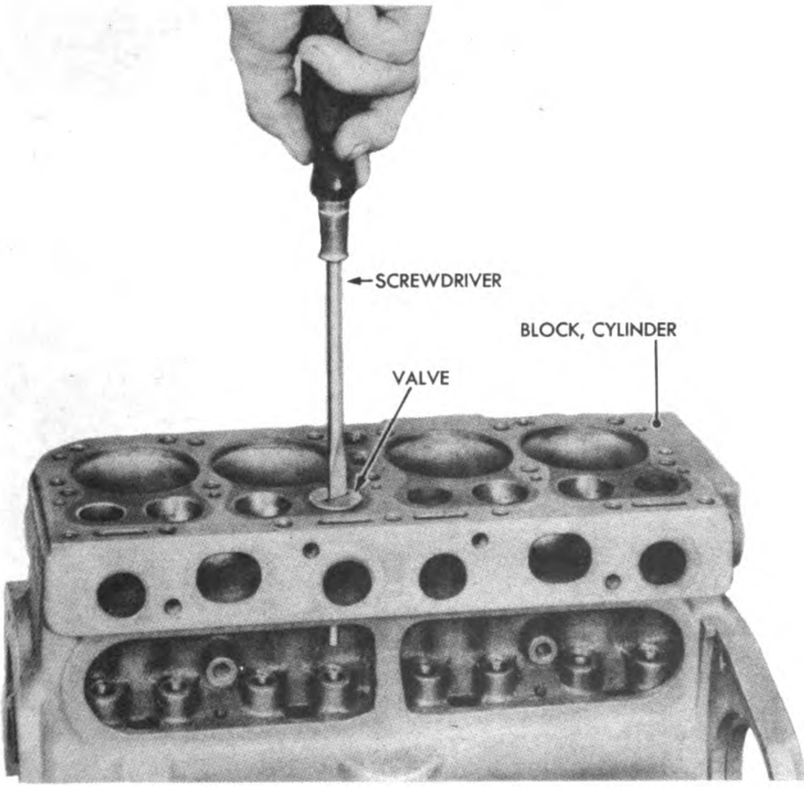

Figure 166 — Testing Valve Fit

correction and repeat test until satisfactory fit is obtained. Lock valve refacer in position and reface all valves.

(3) Lapping Valves.

COMPOUND, valve grinding (fine)
SCREWDRIVER
SOLVENT, dry-cleaning
SPRING, coil

(a) After resurfacing valve seats (par. 124 b (11)) and valves (step (2) above), lap valves as follows:

1. Rub a small amount of fine valve grinding compound on face of the valve. Slip a light coil spring, long enough to hold valve clear of cylinder block, on valve stem.

2. Place valve stem into its guide.

3. Force valve down on its seat, and with a screwdriver in the slot in valve head, oscillate valve back and forth a few times.

4. Remove valve from cylinder block and remove coil spring from valve stem. Wash valve, valve seat, and valve guide with SOLVENT,

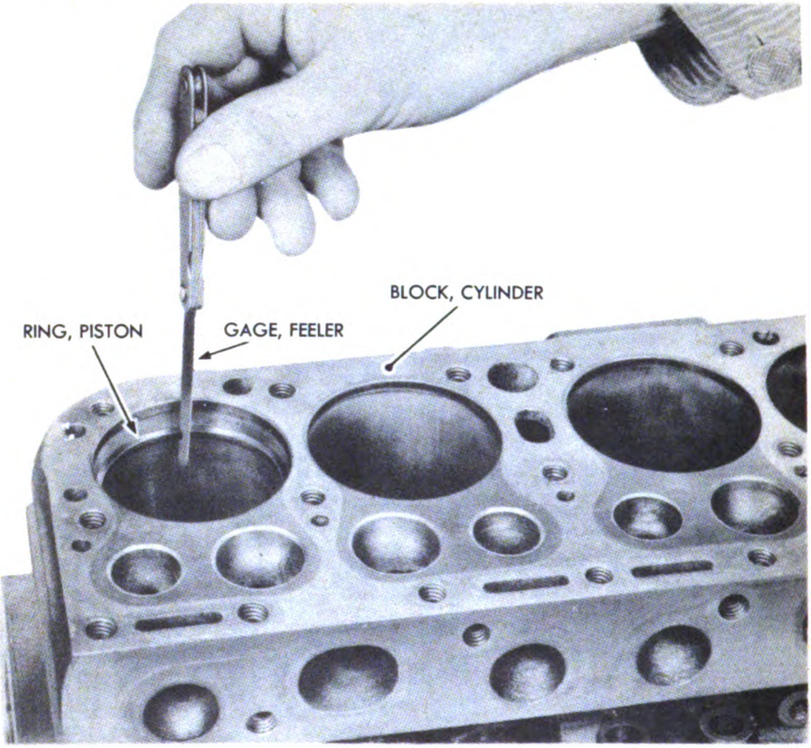

Figure 167 — Measuring Piston Ring End Gap

dry-cleaning, to remove all valve grinding compound. Inspect valve face and seat to see if both have a bright polished appearance.

5. Repeat steps *1* through *4* above to lap each of remaining seven valves.

6. Test valve fit (step (4) below).

(4) Testing Valve Fit.

PENCIL	SCREWDRIVER

(a) After lapping valves, check fit of valve in valve seat as follows:

1. Place pencil marks at intervals around face of valve.

2. Insert valve in its guide (fig. 166).

3. Press valve down to its seat and turn valve a half turn (screwdriver) (fig. 166).

4. Remove valve and inspect face. If pencil marks are rubbed out, the fit is satisfactory. If pencil marks remain, continue to lap the valve until pencil marks are removed by this test.

(5) REPAIRING VALVE TAPPETS.

HONE	STONE, honing

(a) If valve tappet faces are lightly scored, hone them smooth (honing stone). Replace tappet if face is badly scored, or if threads in stem are damaged.

(b) Replace broken, worn, or stripped valve tappet adjusting screw nuts.

(c) If valve tappet is scored or worn enough to allow a 0.005-inch clearance in valve tappet hole in block, install a 0.005-inch oversize tappet. Hone valve tappet holes in cylinder block to fit oversize tappet.

(6) REPAIRING CAMSHAFT.

PRESS, arbor	STONE, honing

(a) Replace camshaft if oil pump drive gear is worn or broken.

(b) Replace camshaft gear if worn or broken (arbor press).

(c) Hone light score marks from cam faces (honing stone). Replace camshaft if bearing journals are scored, or if cams are badly scored.

(d) Replace camshaft thrust washer if worn or scored.

126. PISTON AND CONNECTING ROD REPAIRS.

a. Equipment.

BAR, bending	GAGE, feeler
BLOCK, V—	HONE, cylinder
CLOTH, crocus	HONE, piston pin
EXPANDER, piston ring	INDICATOR, dial
FILE, fine mill	REAMER, ridge
FIXTURE, connecting rod alining	RIBBON, feeler gage, 0.0025-in.
FIXTURE, file holding	WRENCH, socket, ½-in.

b. Procedure.

(1) GENERAL.

(a) Replace connecting rod if bearing is scored, broken, chipped, or burned.

(b) Replace piston pin bushings if worn or damaged.

(c) Replace any damaged connecting rod cap bolt, nut, and connecting rod piston pin lock screw.

(d) Replace worn piston rings.

(e) Replace pistons if scored or out-of-round. Install oversize pistons whenever cylinders are rebored or honed. New pistons must be properly fitted (step (4) below).

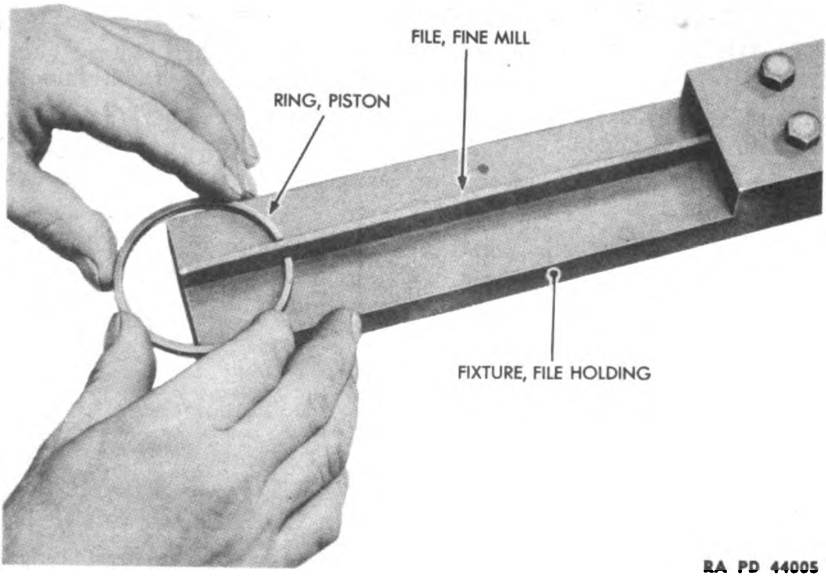

Figure 168 — Filing Ends of Piston Ring

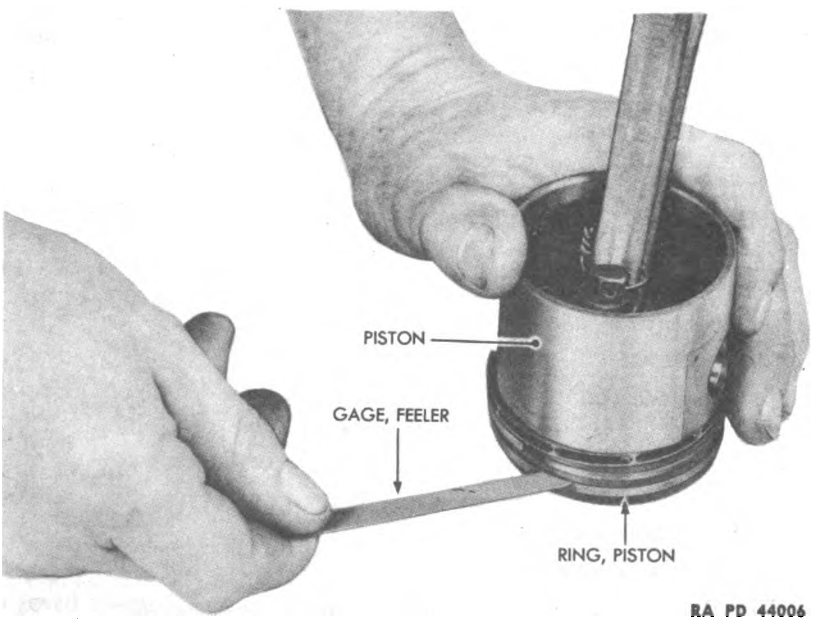

Figure 169 — Measuring Piston Ring Clearance in Groove

(2) FITTING PISTON RINGS.

CLOTH, crocus
EXPANDER, piston ring
FILE, fine mill
FIXTURE, file holding
GAGE, feeler
INDICATOR, dial
REAMER, ridge

(a) Installation of piston rings will correct oil pumping and loss of compression past the piston, provided the pistons and cylinder walls are not damaged or worn excessively. If cylinder wall wear exceeds 0.005 inch, rebore or hone cylinder walls and fit oversize pistons. If cylinder wall wear is 0.003 to 0.005 inch, install oversize piston rings. If cylinder wall wear is less than 0.003 inch, install standard piston rings.

(b) Inspect tops of cylinder bores. If walls are worn, the top three-sixteenths inch will be unworn, and will appear as a ridge. Remove ridge (ridge reamer).

(c) Measure cylinder wall wear (dial indicator) (par. 118 **b** (1) *(c)*) to determine whether to use standard or oversize piston rings.

(d) Slip a piston ring into the cylinder. Push it down about an inch from top of cylinder block with a piston. (This will ensure ring being properly positioned in cylinder wall.) Using a feeler gage, measure end gap (fig. 167). If end gap exceeds 0.020 inch, use an oversize ring. If end gap is less than 0.015 inch, file ends of ring on a fine mill file secured in a file holding fixture (fig. 168). Repeat the step with the remaining 11 rings. Test each ring in the cylinder in which it is to be used.

(e) Carefully examine the ring grooves in each piston. Remove any carbon with a portion of a broken piston ring or standard piston ring groove cleaner. Carefully remove any burs with a fine file. Clean carbon from oil return holes in oil ring groove.

(f) Install all piston rings in proper grooves on piston (piston ring expander). NOTE: Oil ring (slotted ring) belongs in bottom groove of each piston. Compression rings (rings without slots) go in two upper grooves in each piston.

(g) Measure clearance (feeler gage) of each ring in its groove (fig. 169). Proper clearance is from 0.001 to 0.0025 inch. If clearance is under 0.001 inch, remove ring and lap it on CLOTH, crocus, shellacked to a flat surface (fig. 170). Install ring and again check clearance. Repeat operation until proper clearance is obtained. If clearance exceeds 0.0025 inch, use a new piston ring or piston, or both.

(3) FITTING PISTON PINS.

HONE, piston pin

(a) If inspection showed piston pin bushings or piston pin to be worn, the manufacturer recommends replacing both pin and bush-

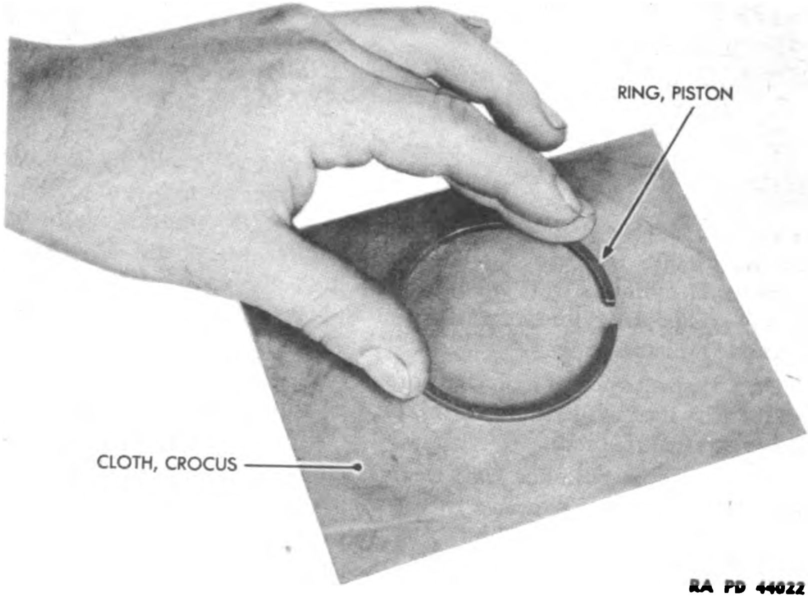

Figure 170 — Lapping a Piston Ring

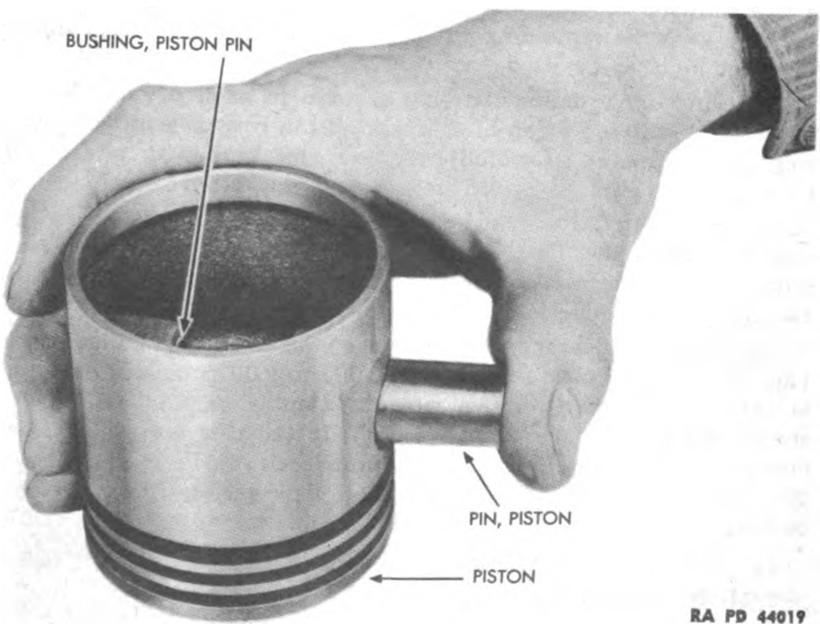

Figure 171 — Testing Fit of Piston Pin

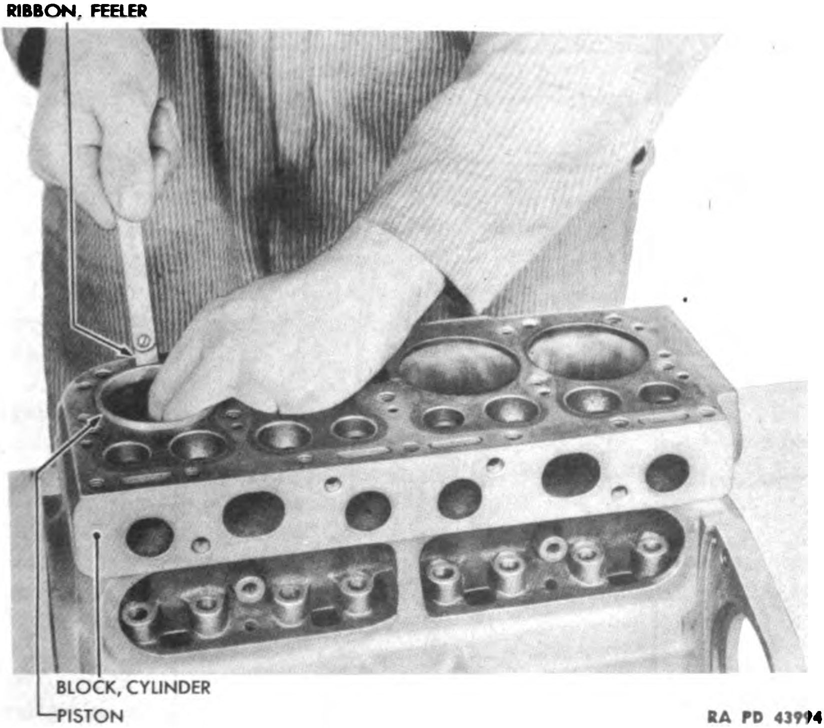

Figure 172 — Measuring Piston Clearance in Cylinder

ings. However, piston pins are supplied 0.003 and 0.005 inch oversize. Oversize pins may be used if bushings are not damaged except for normal wear, provided wear does not exceed 0.005 inch.

(b) Attempt to insert the piston pin into the piston pin bushings installed in the piston. If impossible to insert piston pin in bushings, take a light cut off bushings with a hone. Test the fit again. Repeat the operation until a light push fit of the pin in the bushings is obtained (fig. 171). If the pin fits too loosely, replace the bushings, or replace the pin with an oversize pin.

(4) FITTING PISTONS.

HONE, cylinder	RIBBON, feeler gage, 0.0025-in.

(a) Oversize pistons must be fitted to the cylinders after reboring (par. 124 b (3)) or honing (par. 124 b (4)). The piston is fitted with piston rings and connecting rod removed from the piston (fig. 172).

(b) Insert the end of a 0.0025-inch feeler gage ribbon into the top of cylinder. Push the piston into the cylinder in running position, but upside down. The feeler gage ribbon must be between cylinder

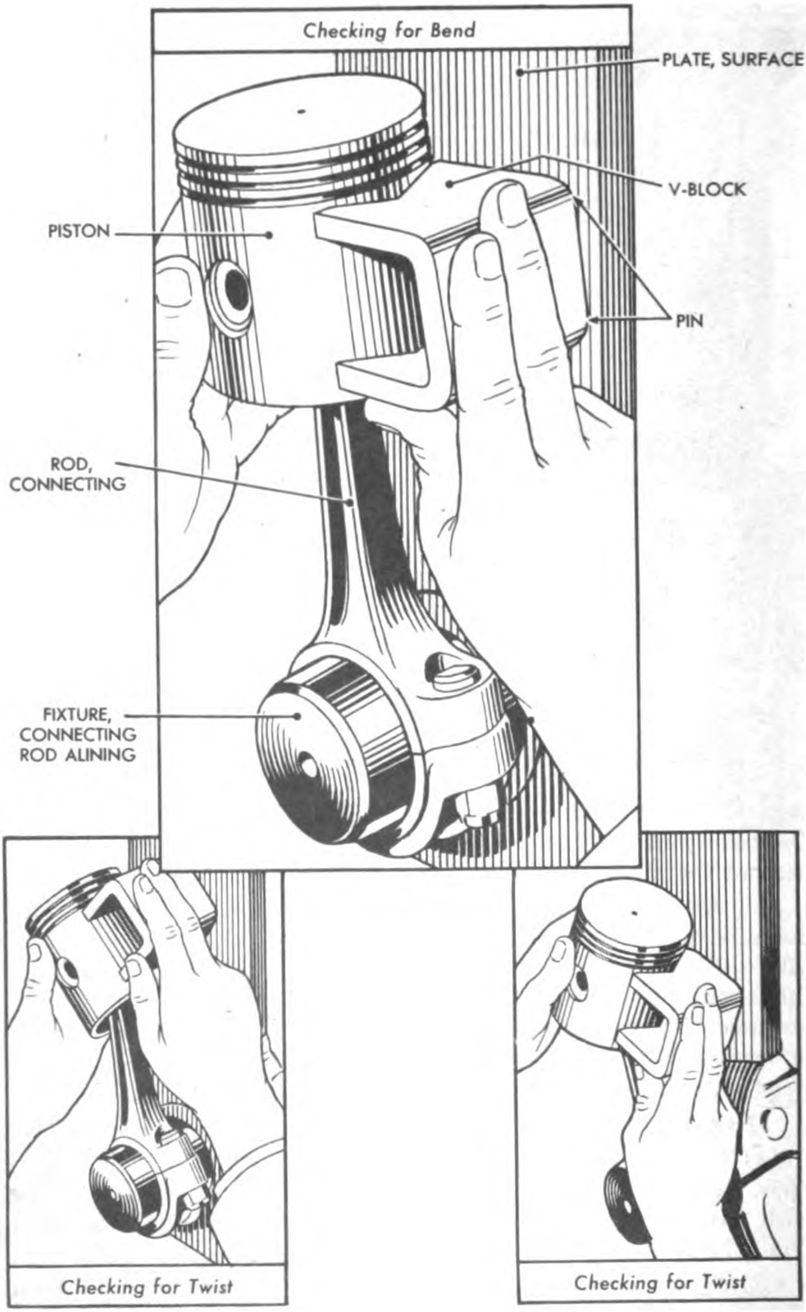

Figure 173 — Connecting Rod Alinement

wall and piston, with end of the feeler gage ribbon projecting from top of cylinder. Pull on feeler gage ribbon. It should pull out with a slight pull. If it binds, hone cylinder wall to provide additional clearance. If it pulls out without resistance, replace piston with a larger oversize and repeat operation.

(5) ALINE CONNECTING RODS.

BAR, bending	FIXTURE, connecting rod alining
BLOCK, V—	WRENCH, socket, ½-in.

(a) Straighten Bent Connecting Rod.

1. Clamp assembled connecting rod and piston, without piston rings, onto a connecting rod alining fixture (½-in. socket wrench) (fig. 173).

2. With piston upright on the connecting rod, hold the V-block against the piston and surface plate (fig. 173). If pins on V-block both touch the surface plate, connecting rod is straight. If only one pin touches the surface plate, connecting rod is bent. Slide a bending bar onto the bent connecting rod, and bend rod until straight.

(b) Straighten Twisted Connecting Rod.

1. Clamp piston and connecting rod assembly onto rod alining fixture as in substep *(a) 1* above. NOTE: A bent rod cannot be checked for twist until straightened.

2. Cock the piston to one side as far as it will go (fig. 173). Place the V-block against piston and surface plate (fig. 173). Slowly rock rod as far as it will go in the opposite direction from which it was cocked. Observe pins of V-block on the surface plate. If neither pin lifts from surface plate as the piston is rocked, connecting rod is free of twist. If one of the pins lifts from surface plate, connecting rod is twisted. Place the bending bar on twisted rod and straighten it.

127. MISCELLANEOUS ENGINE REPAIRS.

a. Equipment.

ANVIL	MACHINE, crankshaft grinding
BAR, straightening	PRESS, arbor (small)
BLOCK, V- (2)	SOLVENT, dry-cleaning
BRUSH, wire	TAP, thread
DOLLY	VISE
DRILL, electric	WELDING EQUIPMENT
HAMMER	

b. Procedure.

(1) REPAIRS TO FAN DRIVE PULLEY.

Replace fan drive pulley, pin, and key if broken.

(2) REPAIRS TO ENGINE AND RADIATOR SUPPORT BRACKETS.

ANVIL	VISE
BAR, straightening	WELDING EQUIPMENT
HAMMER	

(a) Weld engine and radiator support brackets if broken (welding equipment).

(b) Straighten engine and radiator support brackets if bent (vise, straightening bar, hammer, and anvil).

(3) REPAIRS TO OIL PAN.

BRUSH, wire	SOLVENT, dry-cleaning
DOLLY	TAP, thread
HAMMER	WELDING EQUIPMENT

(a) Bump out dents in oil pan (hammer and dolly).

(b) Braze oil pan if cracked (welding equipment).

(c) Clean carbon from oil screen (SOLVENT, dry-cleaning, and wire brush).

(d) Replace damaged oil pan screws and oil screen cover screws.

(e) Tap any burred threads (thread tap).

(4) REPAIRS TO GEAR COVER.

DRILL, electric	PRESS, arbor (small)

(a) Replace gear cover if broken.

(b) Replace thrust screw fiber plug if worn, as follows:

1. Drill worn fiber plug from thrust screw (electric drill).

2. Press new fiber plug into thrust screw (small arbor press).

(c) Replace damaged screws and nuts.

(5) REPAIRS TO IDLER SHAFT ASSEMBLY.

(a) Replace idler gear if teeth are worn or broken.

(b) Replace idler shaft if scored.

(c) Replace idler shaft thrust washer if worn or scored.

(6) REPAIRS TO FLYWHEEL.

TAP, thread

(a) Replace flywheel if broken.

(b) Replace dowel pins with oversize dowels if dowel holes in flywheel are too large. Oversize dowels can be obtained from the engine manufacturer.

(c) If threads are burred in holes tapped for main generator coupling studs, clean up with thread tap. If threads are stripped, the flywheel must be replaced.

(d) Replace ring gear if teeth are worn or broken.

(e) Replace the four main generator couplings if worn or broken.

(7) REPAIRS TO BELL HOUSING.

TAP, thread	WELDING EQUIPMENT

(a) Replace bell housing if broken. A temporary repair can be made by welding if new part is not available.

(b) Tap new threads in tapped holes, if damaged (thread tap).

(c) Replace damaged cap screws, studs, nuts, and lock washers.

(8) REPAIRS TO CRANKSHAFT.

BLOCK, V- (2)
MACHINE, crankshaft grinding
PRESS, arbor (small)

(a) Replace crankshaft gear if worn or broken (arbor press).

(b) Replace crankshaft if threads are stripped in tapped holes on flywheel end (rare).

(c) If bearing journals are scored, burned, or out-of-round, grind the bearing journals to 0.005 to 0.010 inch undersize on a crankshaft grinding machine.

(d) Straighten bent crankshaft in an arbor press. Support its ends on V-blocks. Put pressure on a pilot placed on the high spot on the crankshaft. Remove from arbor press and again check straightness (par. 122 b (1) *(f)*). Repeat the straightening and checking operations until crankshaft is straight.

(9) REPAIRS TO CRANKSHAFT MAIN BEARINGS.

(a) Replace cylinder main bearing if babbitt is chipped, broken, burned, or scored.

(b) Replace damaged cylinder main bearing screws and lock washers.

(10) REPAIRS TO OIL PRESSURE REGULATOR AND CYLINDER PIPE PLUGS. Replace broken, worn, or damaged parts.

128. ACCESSORY DRIVE REPAIRS.

a. Replace accessory drive gear and/or distributor drive gear if teeth are worn or broken.

b. Replace accessory drive shaft if scored or worn.

c. Replace accessory drive shaft thrust washer if scored or broken.

d. Replace accessory drive bushing if worn. No honing or reaming is necessary, since the bushing is furnished reamed to size. Insert the accessory drive shaft into the new bushing. If more than a barely perceptible side play is present, the shaft is worn, and it will be necessary to replace the accessory drive shaft.

e. Replace accessory drive shaft cork washer every time the accessory drive is disassembled. Replace accessory drive oil retainer if broken.

f. Replace accessory drive housing if broken.

Section XVII

ENGINE ASSEMBLY AND INSTALLATION

129. ASSEMBLY.

a. Equipment.

BIT, 5/32-in.
CLOTH, wiping
COMPRESSOR, piston ring
DRIFT
DRILL, electric
DRIVER, stud
EXPANDER, piston ring
GAGE, feeler
HAMMER
HAMMER, soft
LEAD, white
LIFTER, valve
MALLET, rawhide
OIL, engine, SAE 10
OIL, engine, SAE 30
OVEN
PILOT, cup
PLIERS
PLIERS, sharp-nosed
PRESS, arbor
PROBE
REMOVER, valve guide
SCREWDRIVER
SOFT BLOCK
TONGS
VARNISH, shellac
VISE
WOOD BLOCK
WRENCH, box, 9/16-in.
WRENCH, open-end, 3/8-in.
WRENCH, open-end, 7/16-in. (2)
WRENCH, open-end, 9/16-in.
WRENCH, open-end, 13/16-in.
WRENCH, open-end, 15/16-in.
WRENCH, open-end, 1 1/16-in.
WRENCH, socket, 7/16-in.
WRENCH, socket, 1/2-in.
WRENCH, socket, 9/16-in.
WRENCH, socket, 5/8-in.
WRENCH, socket, 3/4-in.
WRENCH, Stillson
WRENCH, torque

b. Procedure.

(1) ASSEMBLE CRANKSHAFT.

HAMMER
LEAD, white
OVEN
PILOT, cup
TONGS

If crankshaft gear has been removed, replace with new gear as follows:

(a) Coat crankshaft gear shoulder on crankshaft, where gear seats, with LEAD, white.

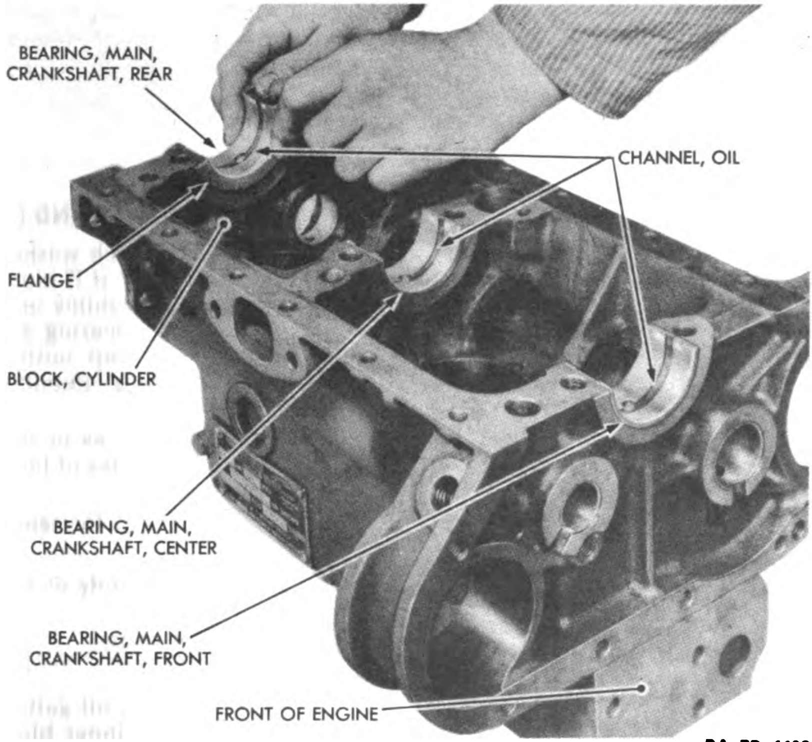

Figure 174 — Installing Crankshaft Main Bearings

(b) Heat crankshaft gear to 160 F in an oven. Using tongs to hold gear, drive gear on crankshaft (hammer and cup pilot). NOTE: Flywheel dowels are not installed in crankshaft until flywheel installation.

(2) INSTALL CRANKSHAFT.

CLEAN CLOTH	WRENCH, socket, ¾-in.
GAGE, feeler	WRENCH, torque
OIL, engine, SAE 10	

(a) Clean cylinder block (clean cloth) and place crankshaft main bearing in place in cylinder block. Oil channels cut in the faces of the bearing go toward the front of the engine. The bearing with the flanges goes to the rear. The bearings were marked at disassembly. Assemble in the same order. If new bearings are being installed, the front and center bearings are interchangeable (fig. 174).

(b) Put a coat of OIL, engine, SAE 10, on crankshaft main bearings. Lay crankshaft in position in bearings (fig. 155).

(c) Install rear main bearing cap, using shims removed at disassembly. If new bearing was installed, use shims totaling 0.005 inch

on each side of bearing. Install main bearing screws and lock washers (¾-in. socket wrench). Revolve crankshaft by hand to see if it binds. Take out enough shims so crankshaft drags slightly. Add shims until binding just disappears. If crankshaft binds on sides of bearing and cap, remove crankshaft and file sides of bearing and cap until a 0.002-inch to 0.0025-inch (feeler gage) clearance is obtained (fig. 155).

(d) Install center main bearing cap. Procedure is same as in substep *(c)* above, except there is no check for clearance on sides of bearing (fig. 155).

(e) Install front main bearing cap. Procedure is same as for center main cap (substep *(d)* above).

(f) Tighten six main bearing cap screws to 75 foot-pounds or 924 inch-pounds pressure (torque wrench with ¾-in. socket).

(3) INSTALL CYLINDER BLOCK PIPE PLUGS.

SCREWDRIVER

Install cylinder block pipe plug at each end of the main oil gallery in cylinder block (screwdriver) (fig. 157). Also install cylinder block pipe plug on accessory side of cylinder block (screwdriver).

(4) INSTALL BELL HOUSING.

GAGE, feeler	WRENCH, open-end, $\frac{9}{16}$-in.
MALLET, rawhide	WRENCH, socket, $\frac{9}{16}$-in.

(a) Using a new gasket, place bell housing in position on cylinder block (fig. 153).

(b) From valve tappet side of cylinder block, install bell housing lock washer and stud nut which secure bell housing to cylinder block ($\frac{9}{16}$-in. open-end wrench) (fig. 154).

(c) From accessory side of engine, install bell housing lock washer and screw, and lock washer and thin head bell housing screw which secure bell housing to cylinder block ($\frac{9}{16}$-in. open-end wrench) (fig. 134). NOTE: Thin head screw goes nearest to cylinder pipe plug hole.

(d) From inside bell housing, install lock washers and screws which secure bell housing to cylinder block ($\frac{9}{16}$-in. socket wrench) (fig. 154).

(e) From inside bell housing, insert a 0.012-inch feeler gage between crankshaft and bell housing (fig. 175). Be certain gage extends clear through opening and is visible on other side of bell housing. Run the gage all the way around the opening between bell housing and crankshaft. A 0.012-inch to 0.025-inch clearance must be maintained at all points. If less than a 0.012-inch clearance exists at any point, loosen bell housing screws and stud nut ($\frac{9}{16}$-in. open-end

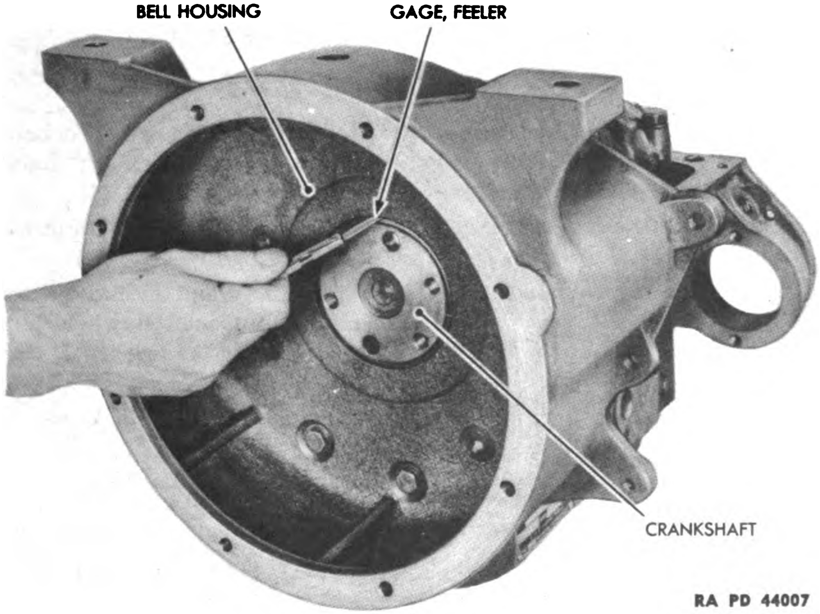

Figure 175 — Checking Crankshaft to Bell Housing Clearance

wrench). Shift position of bell housing by tapping it with a rawhide mallet. Tighten bell housing screws and stud nut ($\frac{9}{16}$-in. open-end wrench). Repeat test and shifting of bell housing until a minimum of a 0.012-inch clearance is obtained at all points (fig. 175).

(5) ASSEMBLE FLYWHEEL ASSEMBLY.

BIT, $\frac{5}{32}$-in.	OVEN
DRILL, electric	PROBE
DRIVER, stud	TONGS
HAMMER, soft	

(a) Heat ring gear to 160 F in an oven. Hold heated ring gear in place on flywheel (tongs) and tap onto flywheel (soft hammer).

(b) Install main generator driving flange studs (stud driver). Tap new lock pins into place in flywheel and stud (hammer). Peen the pins (hammer). Slide main generator driving flange bushings on the studs. Install retaining nuts. If new studs or flywheel or both are used, drill holes for lock pins through inside edge of flywheel rim into studs (electric drill and $\frac{5}{32}$-in. bit). Drill about halfway through the studs. If original flywheel and studs are used, line up pinholes (probe). NOTE: Flywheel expansion plugs are not installed until flywheel installation (step (6) below).

(6) INSTALL FLYWHEEL.

DRIFT	WOOD BLOCK
HAMMER	WRENCH, socket, ⅝-in.
PLIERS	

(a) Place flywheel against end of crankshaft inside of bell housing. Line up screw and dowel holes in flywheel and crankshaft. Install the four crankshaft flywheel bolts fingertight (fig. 153).

(b) Drive the two crankshaft flywheel dowels to seat in crankshaft through their holes in flywheel (hammer and drift) (fig. 153).

(c) Place a wood block between crankshaft and cylinder block to keep crankshaft from revolving. Tighten crankshaft flywheel bolts (⅝-in. socket wrench). Remove wood block (fig. 153).

(d) Install flywheel expansion plugs over crankshaft flywheel dowel openings in flywheel (drift and hammer) (fig. 153).

(e) Install flywheel bolt lock wire (pliers) (fig. 153).

(7) INSTALL VALVE TAPPETS.

(a) Tip engine over so it rests on bell housing (fig. 152).

(b) Screw each valve tappet adjusting screw nut up to head of adjusting screw by hand (fig. 152).

(c) Insert the eight valve tappets into valve tappet guides (holes) in cylinder block from crankshaft side of cylinder block (fig. 152).

(d) Hold the tappets in place with the left hand. Screw the valve tappet adjusting screws into the tops of the valve tappets with the right hand (fig. 152).

(8) ASSEMBLE CAMSHAFT.

HAMMER	PRESS, arbor

(a) Tap camshaft gear key into camshaft (hammer).

(b) Line up camshaft gear key with keyway in gear, and press gear onto camshaft (arbor press) (fig. 148).

(c) Slide camshaft thrust washer on camshaft.

(9) ASSEMBLE IDLER SHAFT.

PRESS, arbor

(a) Press idler shaft gear on idler shaft (arbor press).

(b) Slide idler shaft thrust washer on idler shaft (fig. 149).

(10) ASSEMBLE VALVE TIMING GEARS.

(a) Pull all eight valve tappets toward top of cylinder block. Place camshaft in position in cylinder block (fig. 147). Mesh camshaft gear and crankshaft gear so that prick punch marks are together (fig. 176).

(b) Insert idler shaft into idler shaft bearing. Mesh idler gear with crankshaft gear.

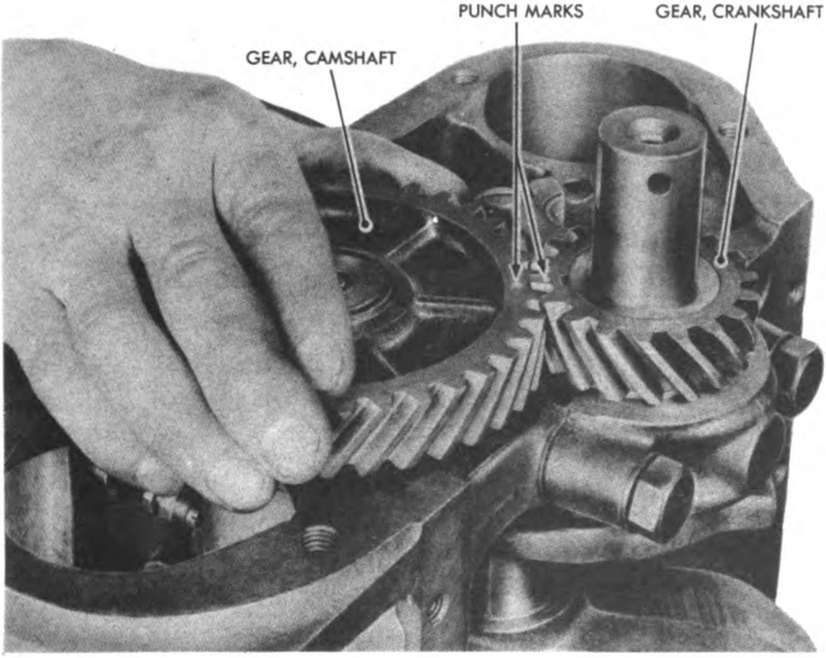

Figure 176 — Valve Timing Gear Assembly

(11) ASSEMBLE GEAR COVER (fig. 146).

HAMMER	SCREWDRIVER
PRESS, arbor	SOFT BLOCK

(a) Tap gear cover oil seal into gear cover (hammer).

(b) Press gear cover thrust screw fiber plugs into thrust screws (small arbor press).

(c) Install gear cover thrust screw assemblies into gear cover (screwdriver).

(d) Drive breather pipe into gear cover (soft block and hammer).

(e) Place oil pan and crankshaft seal in position in gear cover. Felt side goes to outside of gear cover.

(12) INSTALL GEAR COVER.

DRIVER, stud	VARNISH, shellac
GAGE, feeler	WRENCH, socket, $\frac{9}{16}$-in.

(a) Shellac gear cover gasket to gear cover.

(b) Install water pump attaching studs (stud driver) (fig. 152).

(c) Place assembled gear cover in position on top of studs and crankshaft. Insert a narrow 0.015-inch feeler gage between crankshaft, and oil pan and crankshaft seal. With a circular motion, run

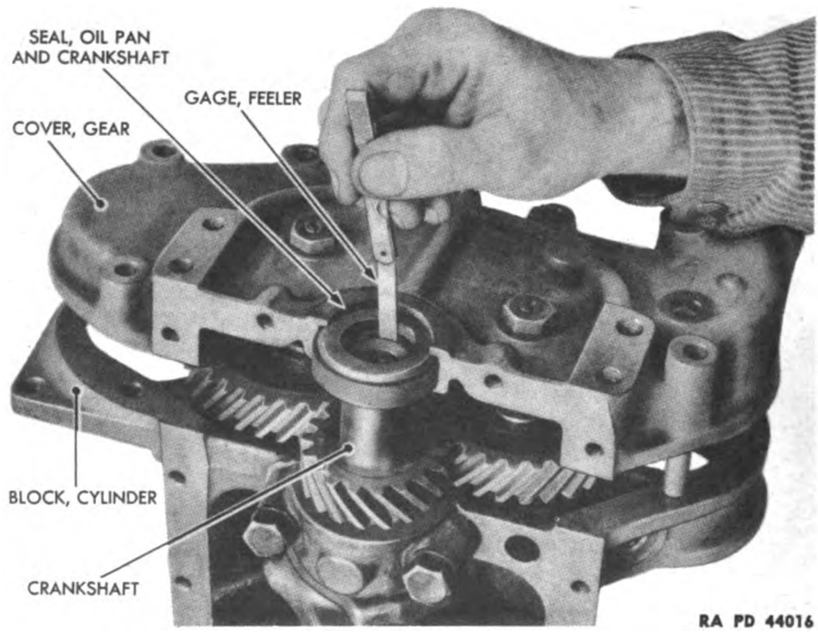

Figure 177 — Installing Gear Cover

feeler gage entirely around crankshaft to start the leather of the seal on the crankshaft (fig. 177).

(d) Push gear cover down into position on cylinder block. Install five lock washers and cap screws ($^9/_{16}$-in. socket wrench) (fig. 143).

(13) Adjust Thrust of Camshaft and Idler Shaft.

SCREWDRIVER	WRENCH, open-end, $1^3/_{16}$-in.

Loosen gear cover thrust screw nuts ($1^3/_{16}$-in. open-end wrench). Tighten gear cover thrust screws, then back each thrust screw off one-eighth turn (screwdriver). Tighten gear cover thrust screw nuts while holding the thrust screw from turning ($1^3/_{16}$-in. open-end wrench and screwdriver) (fig. 144).

(14) Assemble Piston and Connecting Rod.

DRIFT	PRESS, arbor
EXPANDER, piston ring	VISE
PLIERS	WRENCH, socket, $^7/_{16}$-in.

(a) Line up oilholes in piston and piston pin bushing, and press piston pin bushing into piston (arbor press) (fig. 151). Repeat operaton to install other bushing.

Figure 178 — Tightening Connecting Rod Piston Pin Lock Screw

(b) Hold connecting rod in position in piston. Push piston pin in piston and connecting rod.

(c) Tighten connecting rod piston pin lock screw, with piston held on a drift clamped in a vise and inserted into piston pin ($\frac{7}{16}$-in. socket wrench) (fig. 178).

(d) Install lock wire which locks piston pin lock screw (pliers).

(e) Slide one oil and two compression piston rings on piston (piston ring expander).

(f) Repeat substeps *(a)* through *(e)* above to assemble each of the remaining three connecting rod and piston assemblies.

(15) INSTALL PISTONS AND CONNECTING RODS.

COMPRESSOR, piston ring	WRENCH, socket, ½-in.
OIL, engine, (seasonal grade)	WRENCH, torque
WOOD BLOCK	

(a) Compress piston rings on No. 1 piston (piston ring compressor) (cylinder number stamped on camshaft side of connecting rod and cap). Do not place all ring gaps on one side.

(b) Coat piston and connecting rod bearing with thin coat of OIL, engine (seasonal grade).

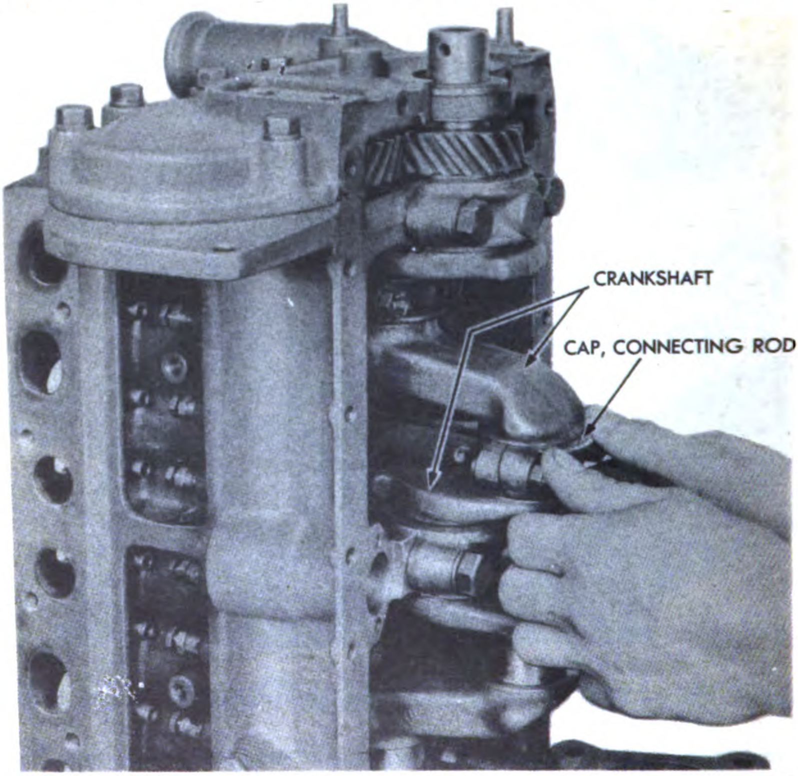

Figure 179 — Adjusting Connecting Rod Bearings

(c) Insert rod and piston assembly, rod first, into top of No. 1 cylinder. Be sure number mark on base of rod is toward camshaft. Tap top of piston in cylinder with wood block. Remove piston ring compressor from piston as piston rings enter cylinder.

(d) Insert connecting rod cap bolts through holes in base of rod. Place three 0.003-inch shims on each bolt. Place connecting rod cap on bolts. Be sure number mark and piston pin lock screw are on side toward camshaft. Install connecting rod bolt nuts, and tighten to 276 inch-pounds pressure (½-in. socket and torque wrenches). Take hold of connecting rod cap with both hands and attempt to move from end to end of bearing journal (fig. 179). Add or remove shims until bearing moves on journal with a definite drag. Then add one shim to each connecting rod cap bolt.

(e) Repeat substeps *(a)* through *(d)* above to install each of remaining connecting rod and piston assemblies.

(16) INSTALL OIL PUMP (par. 160).

ENGINE ASSEMBLY AND INSTALLATION

(17) ASSEMBLY OF OIL PAN.

LEAD, white — WRENCH, Stillson

WRENCH, socket, $\frac{7}{16}$-in.

(a) Place oil pan screen in position in oil pan, and install the screen cover screws and lock washers ($\frac{7}{16}$-in. socket wrench) (fig. 145).

(b) Put a little LEAD, white, on threads of oil drain pipe elbow, and screw elbow in oil pan (Stillson wrench) (fig. 143).

(18) INSTALL OIL PAN.

VARNISH, shellac — WRENCH, socket, $\frac{1}{2}$-in.

WRENCH, box, $\frac{9}{16}$-in. — WRENCH, socket, $\frac{9}{16}$-in.

(a) Shellac oil pan gaskets to oil pan.

(b) Place oil pan in position on cylinder block and bell housing (fig. 145).

(c) Install (fingertight) lock washers and cap screws which hold oil pan to cylinder block and bell housing (fig. 143).

(d) Tighten oil pan to bell housing cap screws adjacent to cylinder block ($\frac{9}{16}$-in. box wrench). Tighten oil pan to cylinder block cap screws adjacent to bell housing ($\frac{1}{2}$-in. socket wrench). Tighten remaining 17 cap screws which secure oil pan to cylinder block and bell housing ($\frac{9}{16}$-in. socket wrench and $\frac{1}{2}$-in. socket wrench). Tighten them alternately, each a little at a time.

(19) INSTALL OIL PRESSURE REGULATOR (figs. 157 and 220).

SCREWDRIVER — WRENCH, open-end, $1\frac{1}{16}$-in.

WRENCH, open-end, $1\frac{5}{16}$-in.

(a) Slide oil pressure regulating piston (cap end last) in cylinder block.

(b) Slide oil pressure regulating spring in cylinder block.

(c) Screw oil pressure regulating adjusting screw in cylinder block until about half is visible (screwdriver).

(d) Slide gasket on adjusting screw.

(e) Install adjusting screw nut on adjusting screw ($1\frac{1}{16}$-in. open-end wrench).

(f) Place other gasket on adjusting screw.

(g) Install acorn nut on adjusting screw ($1\frac{5}{16}$-in. open-end wrench).

(20) INSTALL FAN DRIVE PULLEY.

DRIFT — PLIERS

HAMMER — SOFT BLOCK

(a) Tap fan pulley Woodruff key in its slot in front end of crankshaft (hammer).

(b) Line up fan drive pulley pin holes in pulley and in crankshaft. Drive fan drive pulley on crankshaft (hammer and soft block) (fig. 143).

(c) Drive fan drive pulley pin through pinhole in pulley and crankshaft (hammer and drift) (fig. 143).

(d) Install cotter pin in each end of pin (pliers) (fig. 143).

(21) INSTALL ENGINE AND RADIATOR SUPPORT BRACKETS.

WRENCH, box, $\frac{9}{16}$-in.

(a) Place engine and radiator support brackets in position on front of cylinder block (fig. 143).

(b) Install lock washers and cap screws ($\frac{9}{16}$-in. box wrench).

(22) INSTALL VALVE GUIDES.

HAMMER	REMOVER, valve guide

Install valve guides by driving in from the top down (hammer and valve guide remover).

(23) INSTALL VALVES.

LIFTER, valve	PLIERS, sharp-nosed

(a) Fit valve spring seat in position on end of valve spring.

(b) Slide other end of spring up over valve guide in cylinder block. Push up on valve spring seat to compress valve spring slightly. Slide valve spring seat in position on top of valve tappet adjusting screw.

(c) Insert valve stem in valve guide from top of cylinder block.

(d) Compress valve spring by inserting valve lifter between cylinder block and valve spring seat (fig. 142).

(e) Insert valve spring seat pin in its hole in valve stem (sharp-nosed pliers).

(f) Remove valve lifter.

(g) Repeat process to install remaining valves. NOTE: Be sure to install valves in the same guides from which they were removed.

(24) ADJUST VALVE TAPPETS.

(a) Turn crankshaft until the piston is in firing position, to adjust the valves for that cylinder. When this is done the cams on the camshaft are at the lowest point for valve adjustment. CAUTION: Valves can be closed without the cam being down to the lowest point. If valves are adjusted when the cam is part way up the clearance will not remain the same.

(b) Loosen tappet adjusting screw nut (two $\frac{7}{16}$-in. open-end wrenches) (fig. 180).

(c) Insert an 0.008-inch feeler gage between valve tappet adjusting screw and valve stem (fig. 180). This clearance applies only when the engine is cold.

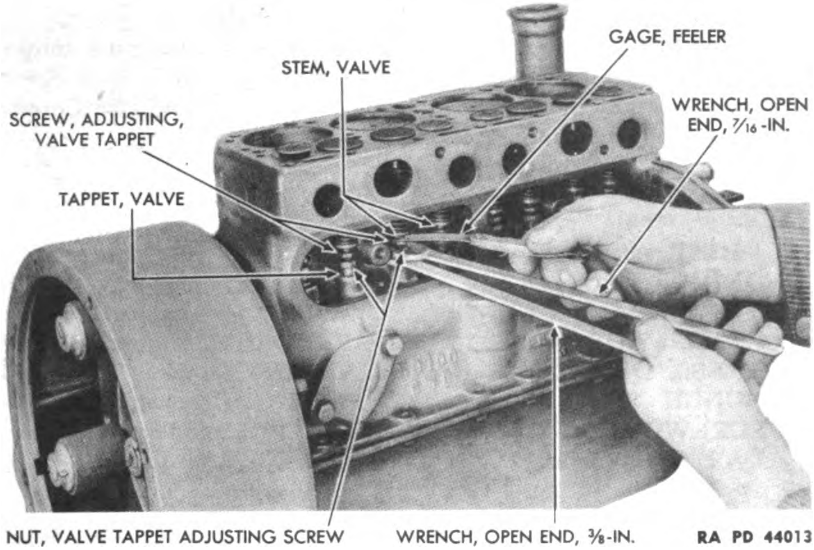

Figure 180 — Adjusting Valve Tappets

(d) Hold tappet to keep it from turning (3/8-in. open-end wrench) and turn tappet adjusting screw in or out (7/16-in. open-end wrench) until feeler gage can be withdrawn with just a slight drag (fig. 180).

(e) Hold tappet adjusting screw to keep it from turning (7/16-in. open-end wrench). Hold tappet to keep it from turning (3/8-in. open-end wrench). Tighten tappet adjusting screw nut against valve tappet (7/16-in. open-end wrench) (fig. 180).

(f) Repeat substeps *(a)* through *(e)* above to adjust remaining seven valve tappets.

(25) INSTALL VALVE COVER.

WRENCH, socket, 1/2-in.

(a) Shellac valve cover gasket to valve cover (fig. 141).

(b) Place valve cover in position on cylinder block, and install screws (1/2-in. socket wrench) (fig. 141).

(26) INSTALL CYLINDER HEAD.

DRIVER, stud	WRENCH, socket, 9/16-in.
OIL, engine (seasonal grade)	WRENCH, torque

(a) Install two cylinder heads to cylinder block studs (stud driver) (fig. 137).

(b) Pour enough OIL, engine (seasonal grade), in each cylinder to coat top of piston.

(c) Place cylinder head gasket and cylinder head in position on top of cylinder block.

(d) Install cylinder head cap screws fingertight.

(e) Tighten cylinder head screws (9/16-in. socket and torque wrench). Begin with center screw and work around it in a clockwise manner, tightening screws at ends of cylinder head last. Correct tension is 42 foot-pounds or 504 inch-pounds.

130. INSTALLATION OF ACCESSORIES.

a. Equipment.

DRIFT, soft	WRENCH, box, ½-in.
DRIVER, stud	WRENCH, open-end, ⅜-in.
HAMMER	WRENCH, open-end, ½-in.
LEAD, white	WRENCH, open-end, 9/16-in.
PRESS, arbor	WRENCH, socket, ½-in.
PUNCH	WRENCH, socket, 9/16-in.
SCREWDRIVER	WRENCH, Stillson
VARNISH, shellac	WRENCH, torque

b. Procedure.

(1) INSTALL SPARK PLUGS (par. 104).

(2) INSTALL OIL DRAIN PIPE.

LEAD, white	WRENCH, Stillson

Put a little LEAD, white, on threads of oil drain pipe. Install drain pipe in elbow (Stillson wrench) (fig. 136).

(3) INSTALL OIL FILTER AND IGNITION COIL BRACKET.

WRENCH, torque

(a) Place bracket spacers on cylinder head studs (fig. 137).

(b) Place oil filter and ignition coil bracket in position on studs and spacers (fig. 137).

(c) Install cylinder head stud nuts which secure bracket to cylinder head. Correct tension is 42 foot-pounds or 504 inch-pounds (9/16-in. socket and torque wrench) (fig. 137).

(4) INSTALL OIL FILLER CAP.

Place oil filler cap in position on breather pipe.

(5) INSTALL MANIFOLD.

DRIVER, stud	WRENCH, socket, 9/16-in.

(a) Install manifold studs (stud driver). Long studs go in center (fig. 141).

(b) Place two manifold gaskets in position on cylinder block. Place exhaust and intake manifold in position on studs (fig. 188).

(c) Install manifold stud flat washers and nuts, and tighten (9/16-in. socket wrench) (fig. 188).

(6) INSTALL GOVERNOR (par. 147).

(7) INSTALL CARBURETOR (par. 142)

(8) INSTALL AUXILIARY GOVERNOR (UNIT M6) (par. 153).

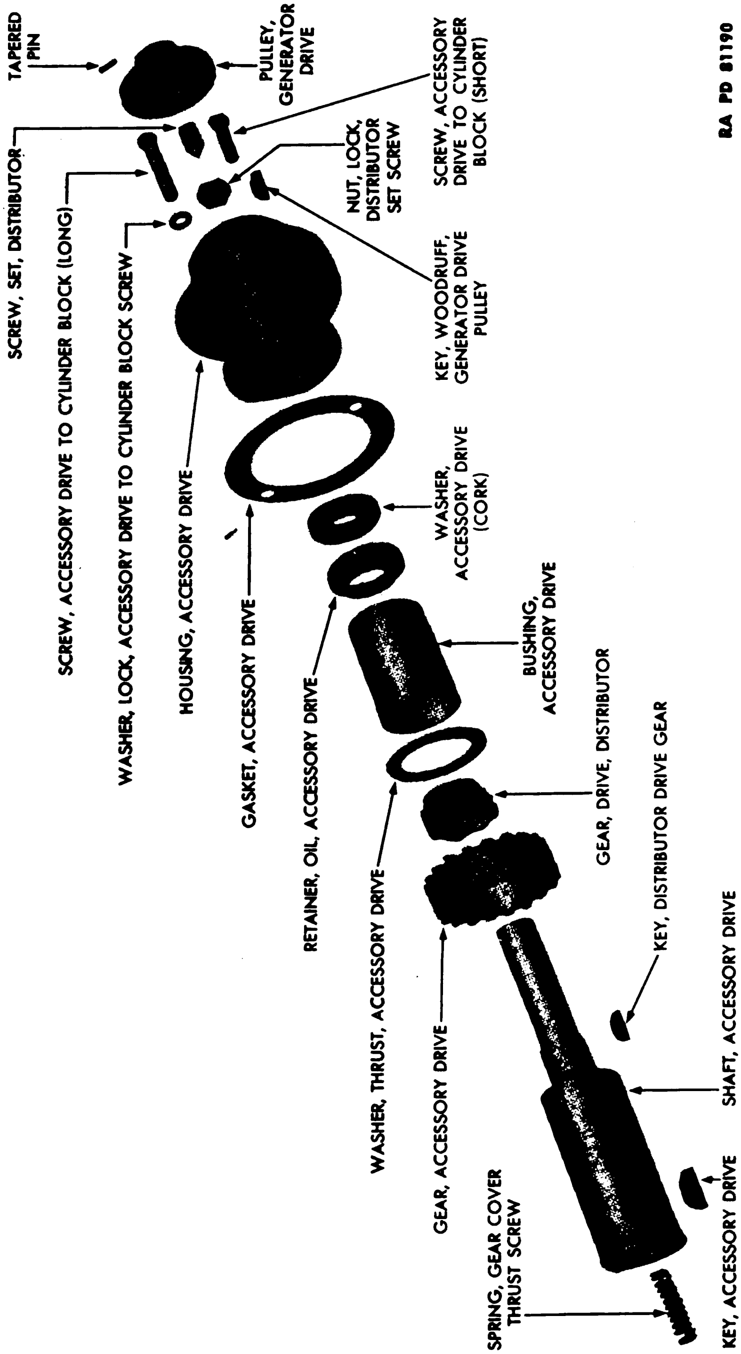

Figure 181 — Accessory Drive Assembly

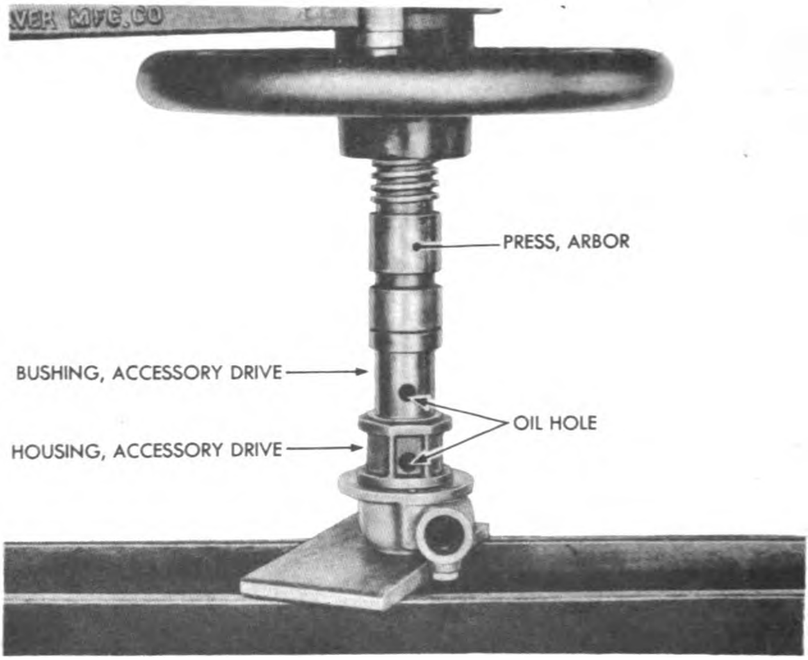

Figure 182 — Pressing Accessory Drive Bushing into Accessory Drive Housing

(9) INSTALL GASOLINE STRAINER (par. 155).

(10) INSTALL AIR CLEANER (par. 136).

(11) ASSEMBLE ACCESSORY DRIVE.

DRIFT, soft	PUNCH
HAMMER	SCREWDRIVER
PRESS, arbor	

(a) Tap distributor driving gear key in accessory drive shaft (hammer). Line up key and keyway. Press distributor driving gear on accessory drive shaft (arbor press) (fig. 139).

(b) Tap accessory drive key in slot in accessory drive shaft (hammer). Line up key in shaft and keyway in gear. Press drive gear on accessory drive shaft (arbor press) (fig. 140).

(c) Slide accessory drive thrust washer on accessory drive shaft (fig. 181).

(d) Install distributor setscrew in accessory drive housing (screwdriver). Install setscrew lock nut on setscrew (fig. 181).

(e) Push accessory drive cork washer and accessory drive oil retainer in place in housing (fig. 181). Tap retainer to seat (soft drift and hammer).

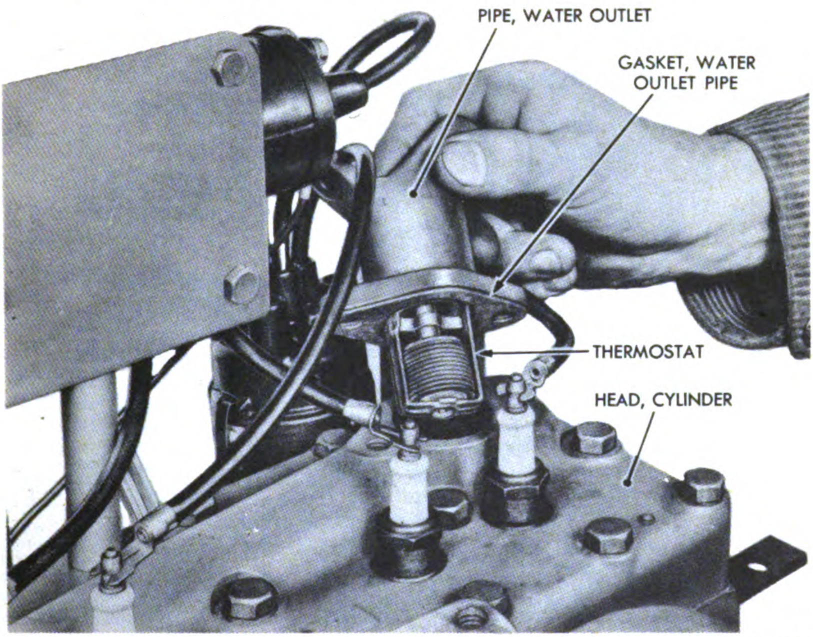

Figure 183 — Installing Water Outlet Pipe and Thermostat Assembly

(f) Line up oilhole in accessory drive bushing with oilhole in housing. Press bushing in housing (arbor press) (fig. 182).

(g) Slide accessory drive shaft assembly in housing assembly (fig. 181).

(h) Tap generator drive pulley Woodruff key in its slot in accessory drive shaft (hammer). Line up keyway in generator drive pulley, and press pulley on shaft (arbor press). Drive tapered pin in its hole through pulley and shaft (hammer). Peen pin in place (hammer and punch) (fig. 181).

(12) INSTALL ACCESSORY DRIVE.

WRENCH, box, ½-in.

(a) Hold accessory drive gasket in place against accessory drive. Push accessory drive in position on cylinder block (fig. 137).

(b) Install lock washers and cap screws (½-in. box wrench) (fig. 137).

(13) INSTALL STARTING MOTOR (par. 112).

(14) INSTALL OIL FILTER AND FITTINGS.

WRENCH, open-end, ⅜-in.
WRENCH, open-end, ½-in.
WRENCH, open-end, 9/16-in.

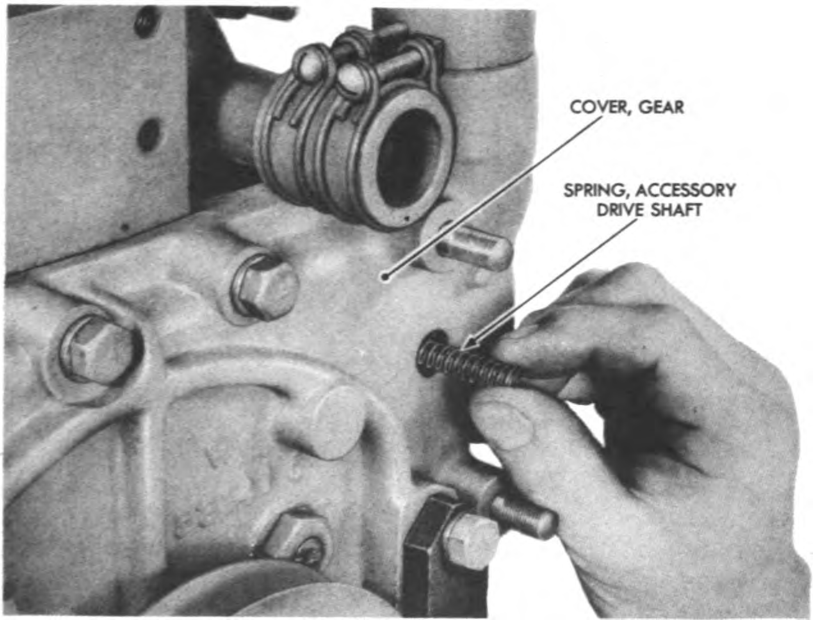

Figure 184 — Installing Accessory Drive Shaft Thrust Spring

(a) Install oil pressure gage "T" on cylinder block (½-in. open-end wrench) (fig. 137).

(b) Install crankcase elbow on cylinder block (⅜-in. open-end wrench) (fig. 137).

(c) Install oil filter (par. 159).

(d) Connect oil filter outlet line to oil filter and to crankcase elbow (⁹⁄₁₆-in. open-end wrench) (fig. 137).

(e) Connect oil filter inlet line to oil filter and oil pressure gage "T" (⁹⁄₁₆-in. open-end wrench).

(15) INSTALL IGNITION COIL (par. 97).

(16) INSTALL THERMOSIPHON COVER AND GENERATOR BRACKET.

VARNISH, shellac	WRENCH, open-end, ⁹⁄₁₆-in.

(a) Shellac gasket to generator support bracket (fig. 137).

(b) Place generator support bracket in position on cylinder block. Install lock washers and cap screws (⁹⁄₁₆-in. open-end wrench) (fig. 137).

(17) INSTALL WATER PUMP DISCHARGE PIPE.

VARNISH, shellac	WRENCH, socket, ½-in.

(a) Shellac new gasket to water discharge pipe.

ENGINE ASSEMBLY AND INSTALLATION

(b) Place discharge pipe in position on cylinder block. Install lower lock washer and cap screw (½-in. socket wrench).

(c) Slide battery charging generator adjustable bracket on upper cap screw and lock washer. Install cap screw (½-in. socket wrench) (fig. 137).

(18) INSTALL BATTERY CHARGING GENERATOR (par. 87).

(19) INSTALL BATTERY CHARGING GENERATOR REGULATOR (par. 93).

(20) INSTALL AND TUNE DISTRIBUTOR (par. 103).

(21) INSTALL WATER OUTLET PIPE AND THERMOSTAT.

VARNISH, shellac WRENCH, open-end, ½-in.

(a) Place thermostat in position on water outlet pipe and shellac gasket to pipe and thermostat (fig. 183).

(b) Place pipe and thermostat assembly in position on cylinder head (fig. 183).

(c) Install water outlet pipe lock washers and cap screws (½-in. open-end wrench) (fig. 136).

(22) INSTALL WATER PUMP AND WATER PUMP DISCHARGE PIPE HOSE.

SCREWDRIVER WRENCH, open-end, ½-in.

(a) Clamp water pump discharge pipe hose to water pump discharge pipe (screwdriver) (figs. 79 and 184).

(b) Insert accessory drive shaft thrust spring in front end of accessory drive through water pump shaft opening in gear cover (fig. 184).

(c) Install water pump (par. 77).

(d) Connect water bypass tube to generator support bracket (½-in. open-end wrench) (fig. 78), and to water pump inlet elbow.

(23) INSTALL FAN.

(a) Install fan and fan belt (par. 79).

(b) Adjust fan belt tension (par. 79).

(24) INSTALL EXHAUST PIPE ADAPTER.

WRENCH, open-end, 9/16-in.

(a) Place exhaust pipe adapter in position on intake and exhaust manifold (fig. 136).

(b) Install lock washers and cap screws (9/16-in. open-end wrench) (fig. 136).

(25) INSTALL MUFFLER.

WRENCH, Stillson

Screw muffler to exhaust pipe adapter (Stillson wrench) (fig. 136). Be sure end of muffler marked "inlet" is toward exhaust pipe adapter.

(26) INSTALL BAYONET OIL GAGE.

Insert bayonet oil gage in its hole in cylinder block (fig. 117).

131. INSTALLATION.

a. Equipment.

HOIST, chain
SCREWDRIVER
SLING, rope
WRENCH, open-end, 3/8-in.
WRENCH, open-end, 1/2-in.
WRENCH, open-end, 9/16-in.
WRENCH, open-end, 5/8-in.
WRENCH, open-end, 3/4-in.
WRENCH, Stillson

b. Procedure.

(1) Lift engine in position in frame (two men) (fig. 133).

(2) Install rear engine mounting lock washers and cap screws, and front engine mounting lock washers and cap screws (3/4-in. open-end wrench) (fig. 133). NOTE: Cable clip goes on right-hand rear engine mounting cap screw (fig. 135).

(3) Install main generator and instrument panel assembly (par. 28) (figs. 134 and 135).

(4) Install drain cock in water pump inlet elbow (5/8-in. open-end wrench) (fig. 134).

(5) Install radiator (par. 78).

(6) Install battery (par. 113).

(7) Install housing (par. 19).

(8) Install oil drain pipe cap on oil drain pipe (Stillson wrench) (fig. 3).

132. TESTS AND ADJUSTMENTS.

a. Equipment.

GASOLINE
OIL, engine (seasonal grade)
WATER

b. Procedure.

(1) PRECAUTIONS BEFORE STARTING ENGINE.

GASOLINE
OIL, engine (seasonal grade)
WATER

(a) Fill crankcase to "4/4" mark on bayonet oil gage with OIL, engine (seasonal grade). Capacity of crankcase is 4 quarts.

(b) Fill cooling system with water or antifreeze solution. Capacity is 5 quarts.

(c) Fill gasoline tank with gasoline.

(d) Check cooling system for water leaks. Repair if found.

(e) Check engine for oil leaks. Repair if found.

ENGINE ASSEMBLY AND INSTALLATION

(f) Open gasoline tank shut-off cock, and check fuel system for gasoline leaks. Repair if found.

(g) Examine ignition wires. See that all connections are made, and that they are tight.

(h) Lubricate engine accessories (pars. 162 and 165).

(i) Crank engine over a few times by hand. This will determine whether the engine is free without causing any damage.

(2) PRECAUTIONS AND ADJUSTMENTS AFTER STARTING ENGINE.

(a) Immediately after starting engine, observe oil pressure gage and ammeter. Turn ignition off immediately if no oil pressure or no charging rate is indicated. Locate and correct the cause.

(b) Listen for knocks or noises indicating malfunctioning of engine or accessories. Locate and correct the cause of any such noise.

(c) Inspect cooling system for leakage. Repair if leakage is present.

(d) Inspect engine for oil leakage. Repair if leakage is present.

(e) Inspect manifold, exhaust pipe, and muffler for exhaust leakage. Repair if leaking.

(f) Adjust charging rate of battery charging generator. The rate of charging may be decreased by shifting the smaller or third brush away from the nearest main brush, or increased by moving it nearer to the main brush. Remove generator head band to expose brushes.

(g) Add OIL, engine (seasonal grade), to "4/4" mark, to compensate for oil contained in oil filter.

(h) After engine has run for 15 minutes, adjust oil pressure to 15 pounds (par. 161 d). With engine warm, adjust valve tappets to a 0.006-inch clearance (par. 129 b (24)).

1. After engine has warmed up, check to make sure the engine bolts are down tight.

Section XVIII

FUEL SYSTEM

133. DESCRIPTION.

a. The fuel system consists of a gasoline tank, gasoline strainer, carburetor, air cleaner, governor, and choke control.

b. The gasoline tank is equipped with a gage, filler cap shut-off cock, and gasoline line. This assembly is a part of the housing, and is covered in paragraphs 12 to 19.

c. From the gasoline line, fuel flows into a gasoline strainer attached to the carburetor. It consists of a sediment bowl and disk-type element through which the gasoline must pass. The strainer prevents dirt and other foreign particles, and water from entering the carburetor.

d. The function of the carburetor is to convert liquid gasoline to a highly explosive gasoline vapor and air mixture (fig. 185). Air

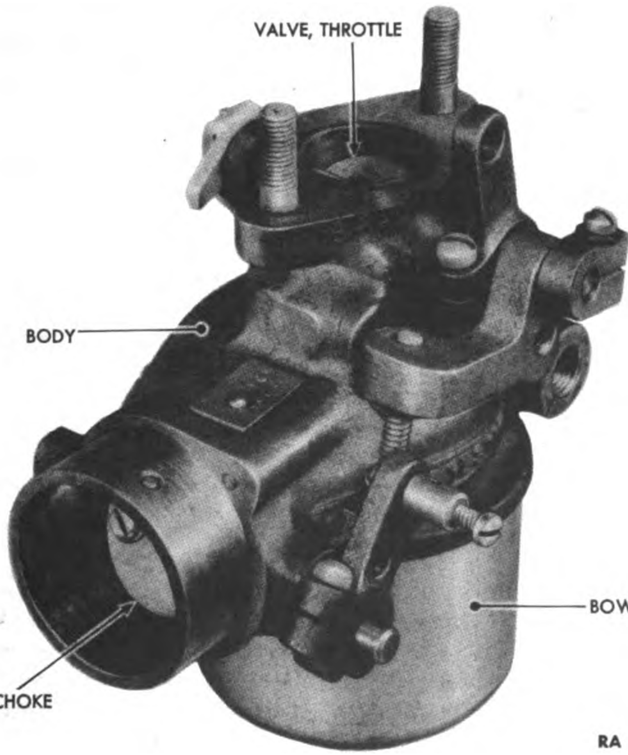

Figure 185 — Carburetor

rushing from the atmosphere through the carburetor to the partial vacuum of the manifold furnishes the force which makes the carburetor operate.

(1) The flow of gasoline from the gasoline strainer to the carburetor is regulated by the carburetor float valve. The float valve is controlled by the carburetor float. As the carburetor float bowl (fig. 185) empties, the float falls and opens the float valve. This allows gasoline to flow into the bowl. As the bowl fills, the float rises and closes the float valve. Thus, the fuel level in the float bowl is kept at an efficient operating level.

(2) Air enters the carburetor body (fig. 185) from the air cleaner, and passes through the body into the intake manifold. As it goes through the body, gasoline is mixed with it, as the gasoline sprays from the carburetor nozzle assembly. The Venturi swirls the mixture, thus insuring complete mixing of gasoline vapor and air.

(3) The carburetor throttle valve (fig. 185) controls engine speed by regulating the quantity of vapor and air mixture to be admitted to the manifold.

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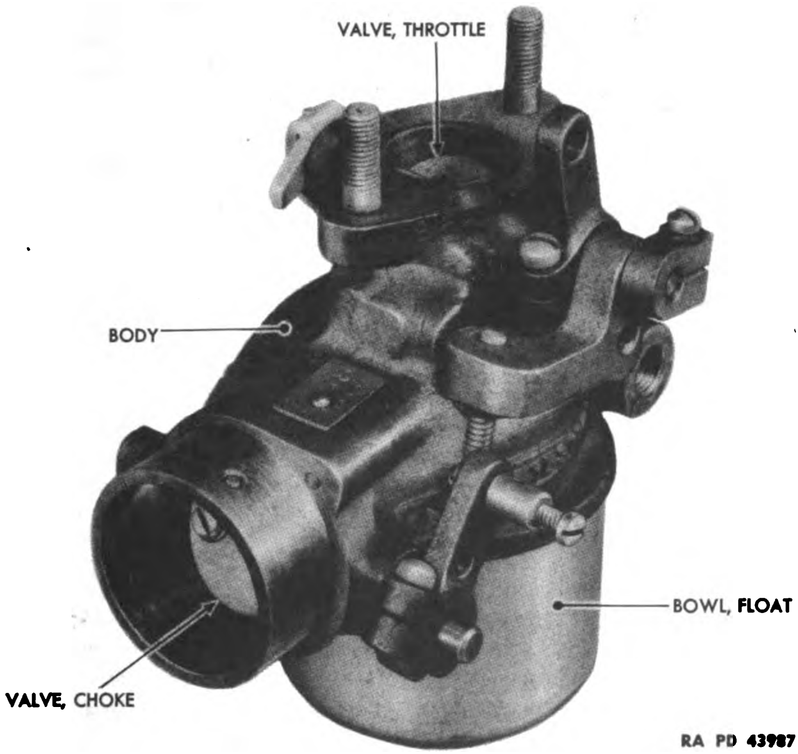

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(3) The carburetor throttle valve (fig. 185) controls engine speed by regulating the quantity of vapor and air mixture to be admitted to the manifold.

(4) To facilitate starting when the engine is cold, a choke valve (fig. 185) is provided. The choke valve partially closes the air passage from the air cleaner to the carburetor body. This causes more gasoline vapor and less air to be used in the mixture.

(5) Of conventional automotive design, the carburetor is of the up draft type. No adjustment is provided, except for regulation of idling speed. This is done by regulating the degree to which the throttle valve can close. If engine performance should indicate a too rich or too lean mixture, the carburetor must be disassembled and cleaned.

e. Abrasive dirt in the air is removed from the air entering the carburetor by the air cleaner. The air is drawn through a screen kept constantly moist with oil vapor. Impurities in the air adhere to the oil. The oil is then washed down into the oil reservoir, taking the dirt with it. The air cleaner mounting bracket is cast iron. The filtering element consists of four layers of crimped 18-mesh iron screen. The two gaskets are cork. All other parts are made of sheet metal.

f. The governor is of the centrifugal mechanical type and is gear-driven by the front end gear train. The flyball weights are counterbalanced with an external spring pressure. The tension of this spring can be changed to operate the engine at the speed desired. At all loads within the rating of the generator, the governor maintains the speed regulation to within ± 3 percent.

g. An auxiliary governor is used on the Unit M6 to prevent surging of the engine as the load varies. This is necessary since the Unit M6 has no throttle control. Vacuum of the intake manifold operates the auxiliary governor. Decreased vacuum, caused by increased engine load, allows the bellows to contract. Contraction of the bellows lowers the plunger which opens the carburetor throttle valve. This allows more fuel to flow from the carburetor into the manifold. The added fuel compensates for the increased engine load, and allows the engine to maintain its speed. Steel, brass, and copper are used in the construction of the auxiliary governor. Steel parts are the support plate, screws, and lock washers. Brass parts are the bellows housing, base, orifice, plunger, and vacuum tube elbow. The vacuum tube is copper.

134. SPECIFICATIONS.

a. Air Cleaner.

Make .... Air-Maze
Type .... Oil bath
Oil capacity .... ⅓ pt

b. Carburetor.

Make .... Schebler
Model TCX-39
Type .... Updraft
Adjustment .... Idling speed

c. Governor.

Make .... Pierce
Model .... CS
Type .... Mechanical
Speed regulation .... ± 3 percent

d. Auxiliary Governor (Unit M6 Only).

Make .... Hobart
Type .... Vacuum

e. Choke Control.

Make .... Morse
Model 4K
Type .... Manual

f. Gasoline Strainer.

Make .... Zenith
Model ZX-1-G1
Type .... Sediment bowl

135. TROUBLE SHOOTING.

a. Carburetor.

(1) CARBURETOR DRIPS GASOLINE.

Possible Cause	Possible Remedy
Saturated float.	Replace float (pars. 138 and 141).
Worn float needle valve.	Replace float needle valve and float needle valve seat (pars. 138 and 141).
Float bowl gasket damaged or defective.	Replace gasket (pars. 138 and 141).
Body or float bowl broken.	Replace broken part (pars. 138 and 141).
Choke valve stuck closed.	Free choke valve (pars. 138 and 141).
Choke lever loose on shaft, and valve closed.	Open valve and tighten choke lever clamp screw (par. 141).

(2) CARBURETOR DOES NOT RESPOND TO CONTROLS.

Possible Cause	Possible Remedy
Throttle lever clamp screw loose.	Tighten throttle lever clamp screw.
Throttle lever stuck.	Free throttle lever.

(3) CARBURETOR DELIVERS TOO RICH OR TOO LEAN MIXTURE.

Possible Cause	Possible Remedy
Dirt in carburetor.	Disassemble and clean carburetor (par. 138).

b. Governor.

(1) ENGINE RUNS TOO FAST OR TOO SLOW.

Governor out of adjustment.	Adjust governor (par. 148).
Governor broken.	Repair governor (par. 145).

(2) ENGINE SURGES.

Governor out of adjustment.	Adjust governor (par. 148).
Governor broken.	Repair governor (par. 145).

c. Auxiliary Governor (Unit M6).

(1) ENGINE SURGES.

Auxiliary governor broken.	Repair auxiliary governor.

d. Choke Control.

(1) CARBURETOR DOES NOT RESPOND TO CHOKE CONTROL.

Choke control disconnected.	Connect choke control (par. 154).
Choke control broken.	Repair or replace choke control (par. 154).

e. Gasoline Strainer.

(1) DRIPS GASOLINE.

Bowl gasket damaged.	Replace bowl gasket (par. 155).
Bail thumbscrew loose.	Tighten bail thumbscrew.
Bowl broken.	Replace bowl (par. 155).
Head broken.	Replace head (par. 155).
Male coupling loose.	Tighten male coupling.
Male coupling broken.	Replace male coupling (par. 155).
Elbow loose.	Tighten elbow.
Elbow broken.	Replace elbow (par. 155).

(2) GASOLINE FAILS TO FLOW THROUGH STRAINER.

Strainer clogged by dirt.	Clean strainer (par. 155).

(3) FAILS TO REMOVE IMPURITIES FROM FUEL.

Disks in strainer element bent.	Replace element (par. 155).

f. Air Cleaner.

(1) FAILS TO REMOVE DIRT FROM AIR.

Out of oil.	Service air cleaner (par. 136).
Bracket loose.	Tighten bracket.
Element fouled.	Service air cleaner (par. 136).
Oil bath fouled.	Service air cleaner (par. 136).

(2) DRIPS OIL.

Wing nut loose.	Tighten wing nut.
Gasket damaged.	Replace gasket (par. 136).

FUEL SYSTEM

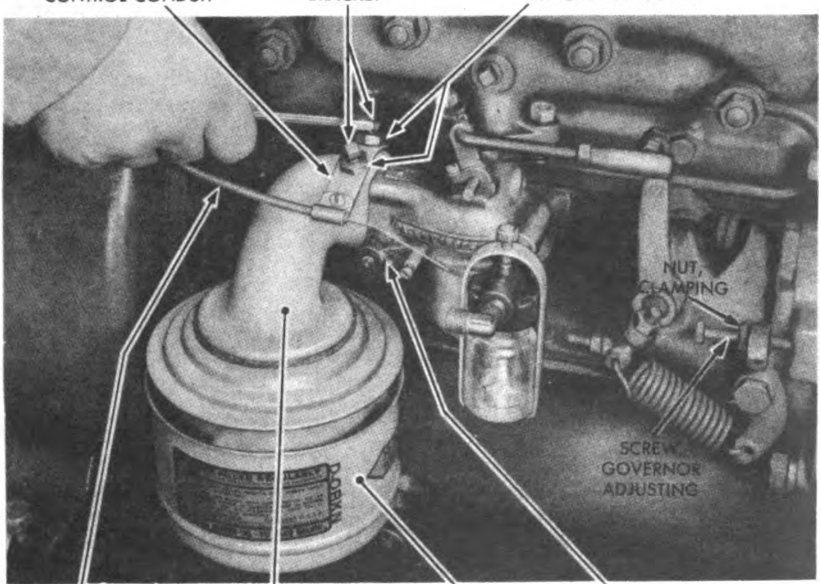

Figure 186 — Removing Air Cleaner

(3) AIR PASSAGE BLOCKED.

Possible Cause	Possible Remedy
Air cleaner assembled incorrectly.	Assemble correctly (par. 136).
Dirt in element.	Service air cleaner (par. 136).

136. AIR CLEANER.

a. Equipment.

DOLLY	SHELLAC
HAMMER	SOLDERING EQUIPMENT
KNIFE	WELDING EQUIPMENT
OIL, engine (seasonal grade)	WRENCH, open-end, ¼-in.
SCREWDRIVER	WRENCH, open-end, ½-in.

b. Procedure.

(1) REMOVAL (fig. 186).

SCREWDRIVER — WRENCH, open-end, ½-in.
WRENCH, open-end, ¼-in.

(a) Disconnect choke control wire from choke valve lever (screwdriver).

(b) Loosen air cleaner bracket setscrew lock nuts (½-in. open-end wrench) (fig. 186).

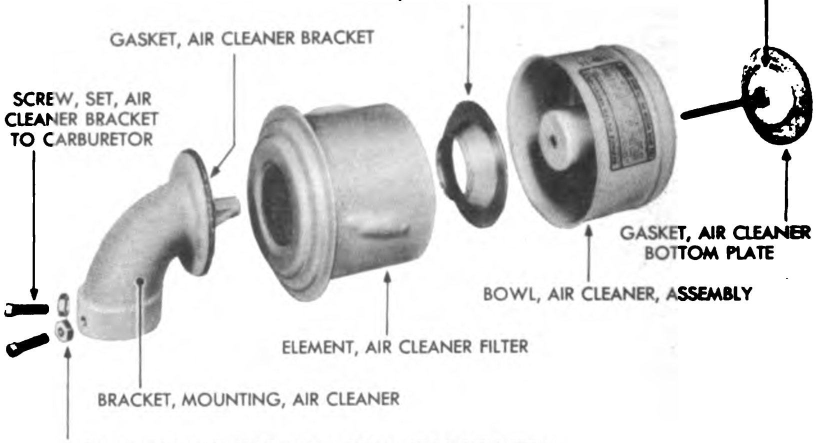

Figure 187 — Air Cleaner Assembly — Exploded View

(c) Remove air cleaner bracket setscrews (¼-in. open-end wrench). Lift off choke control conduit clamp.

(d) Lift air cleaner bracket and air cleaner assembly from carburetor.

(2) DISASSEMBLY (fig. 187).

KNIFE	WRENCH, open-end, ½-in.
WRENCH, open-end, ¼-in.	

(a) Loosen wing nut in center of bottom plate.

(b) Lift bottom plate and gasket.

(c) Lift bowl from filter element, and remove baffle plate from bowl.

(d) Lift mounting bracket from element.

(e) Unscrew bracket to carburetor setscrews and lock nuts from bracket (¼-in. open-end wrench and ½-in. open-end wrench).

(f) Remove gaskets from bracket and bottom plate (knife). NOTE: Gaskets will probably be damaged upon removal. Therefore, do not remove gaskets unless replacement is necessary.

(3) INSPECTION AND REPAIR.

DOLLY	SOLDERING EQUIPMENT
HAMMER	WELDING EQUIPMENT

(a) Examine threads of bottom plate assembly and threads of the setscrews and lock nuts. Replace if damaged.

(b) Inspect bracket for fracture. Weld or replace if broken (welding equipment).

(c) Examine filter element to see if it is bent, or if screen is loose from sheet metal. Straighten if bent (hammer and dolly). Solder screen to sheet metal if loose (soldering equipment).

(d) Inspect baffle plate and bowl to see if bent. Straighten if bent (hammer and dolly).

(e) Pour water in bowl to test for leakage. Solder any leaks (soldering equipment).

(f) Examine bracket gasket and bottom plate gasket. Replace if torn or crushed.

(4) ASSEMBLY (fig. 187).

OIL, engine (seasonal grade) VARNISH, shellac

(a) Shellac gasket to mounting bracket.

(b) Shellac gasket to bottom plate.

(c) Pour OIL, engine (seasonal grade), in bowl to bead level (about one-third pint).

(d) Place filter element in position on bracket. Slip baffle plate in position in bowl. Hold bowl in place on element. Place wing nut and bottom plate assembly in position on bottom of bowl. Tighten wing nut.

(e) Tighten bracket to carburetor setscrew and lock nut by hand.

(5) INSTALLATION (fig. 186).

SCREWDRIVER WRENCH, open-end, ½-in.
WRENCH, open-end, ¼-in.

(a) Place assembled air cleaner and air cleaner bracket in position on carburetor.

(b) Place choke control conduit clamp in position on air cleaner bracket.

(c) Install setscrews (¼-in. open-end wrench).

(d) Tighten setscrew lock nuts (½-in. open-end wrench).

(e) Connect choke control wire to choke valve lever (screwdriver).

(6) SERVICING AIR CLEANER.

OIL, engine (seasonal grade) WRENCH, open-end, ½-in.
WRENCH, open-end, ¼-in.

(a) Daily Inspection.

1. Check tightness of bracket to carburetor setscrews and lock nuts (¼- and ½-in. open-end wrenches), and bottom plate wing nut.

2. Under extremely dusty conditions, change oil in bowl daily (step (2) below).

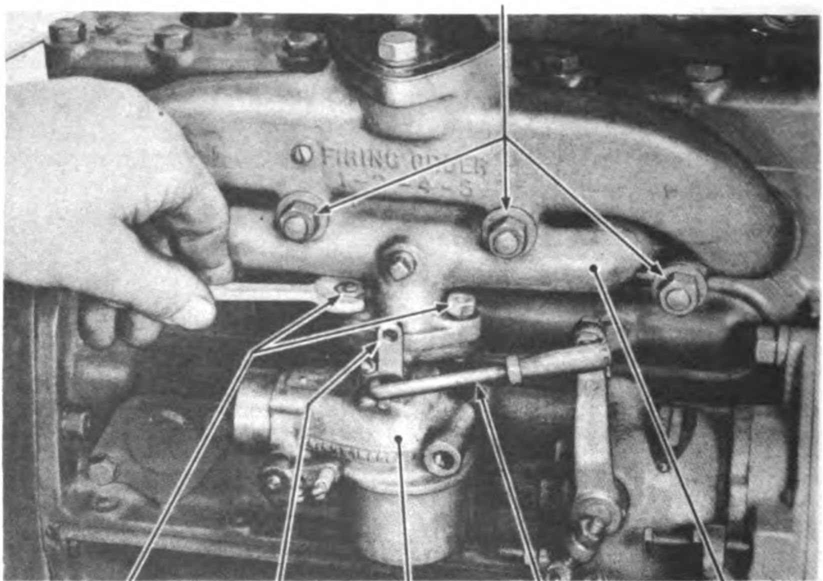

Figure 188 — Removing Carburetor

(b) *Weekly Servicing.*

1. Remove bottom plate and remove bowl from air cleaner. Empty bowl. Refill with OIL, engine (seasonal grade).

2. Wash the filter element in SOLVENT, dry-cleaning. CAUTION: Do not use gasoline.

137. REMOVAL OF CARBURETOR.

a. Equipment.

PLIERS
WRENCH, open-end, 5/16-in.
WRENCH, open-end, 7/16-in.

b. Procedure (fig. 188).

(1) Remove air cleaner (par. 136).

(2) Remove gasoline strainer (par. 155).

(3) Remove governor connecting rod cotter pin, and pull governor connecting rod from throttle lever (pliers).

(4) Unscrew auxiliary governor connecting rod from throttle lever (5/16-in. open-end wrench).

(5) Remove throttle flange stud nuts and lock washers (7/16-in. open-end wrench).

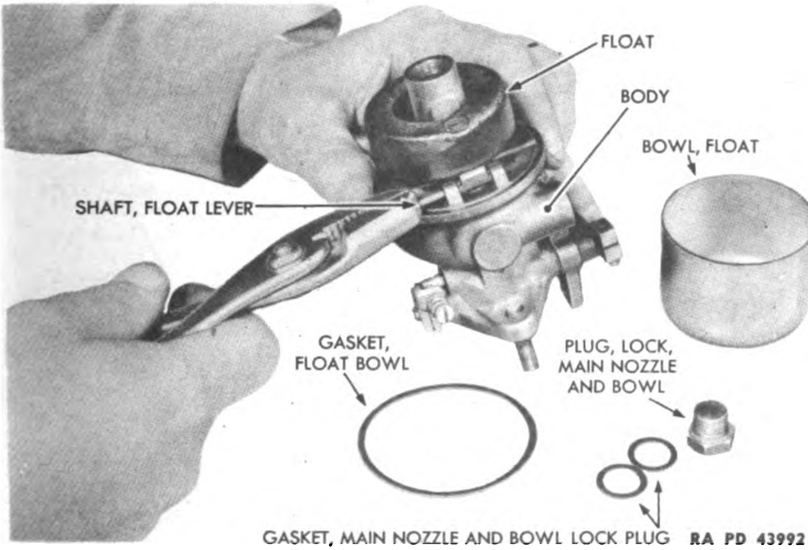

Figure 189 — Removing Carburetor Float Lever Shaft

(6) Lift carburetor from intake and exhaust manifold. Lift gasket from carburetor.

138. DISASSEMBLY OF CARBURETOR.

a. Equipment.

PLIERS
SCREWDRIVER
WRENCH, open-end, ⅝-in.

b. Procedure (fig. 189).

(1) Remove main nozzle and bowl lock plug and outside gasket (⅝-in. open-end wrench).

(2) Lift float bowl from body, and lift main nozzle and bowl lock plug inside gasket, from bowl.

(3) Lift float bowl gasket from body.

(4) Pull float lever shaft from carburetor body (pliers).

(5) Lift float from carburetor body.

(6) Remove float lever screw and washer from float (screwdriver). Lift float lever from float (fig. 190).

(7) Turn body over. Float valve will fall from float valve seat (fig. 190).

(8) Remove float valve seat and gasket (screwdriver) (fig. 190).

(9) Remove main nozzle assembly and gasket from body (screwdriver) (fig. 190).

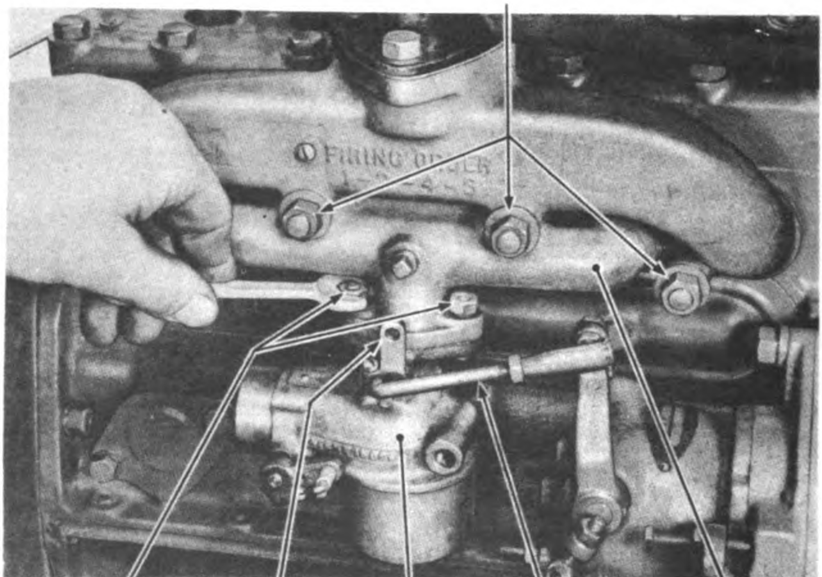

Figure 188 — Removing Carburetor

(b) *Weekly Servicing.*

1. Remove bottom plate and remove bowl from air cleaner. Empty bowl. Refill with OIL, engine (seasonal grade).

2. Wash the filter element in SOLVENT, dry-cleaning. CAUTION: Do not use gasoline.

137. REMOVAL OF CARBURETOR.

a. Equipment.

PLIERS
WRENCH, open-end, 7/16-in.
WRENCH, open-end, 5/16-in.

b. Procedure (fig. 188).

(1) Remove air cleaner (par. 136).

(2) Remove gasoline strainer (par. 155).

(3) Remove governor connecting rod cotter pin, and pull governor connecting rod from throttle lever (pliers).

(4) Unscrew auxiliary governor connecting rod from throttle lever (5/16-in. open-end wrench).

(5) Remove throttle flange stud nuts and lock washers (7/16-in. open-end wrench).

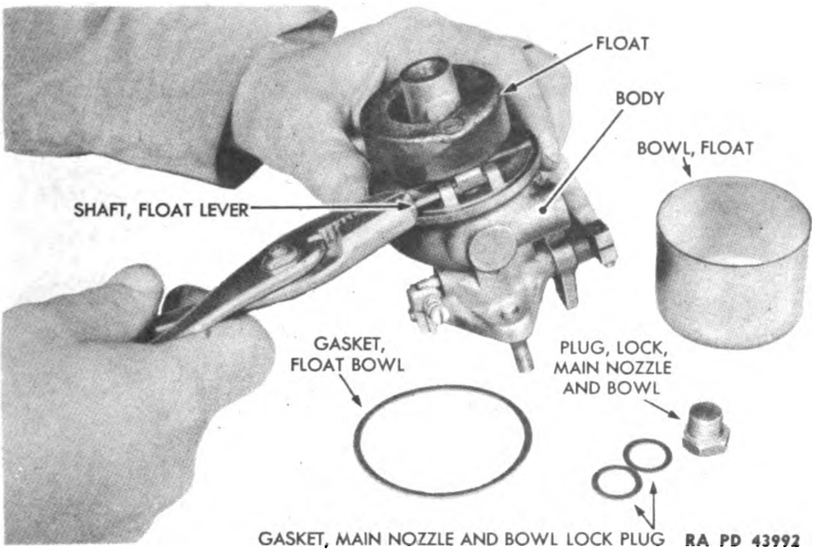

Figure 189 — Removing Carburetor Float Lever Shaft

(6) Lift carburetor from intake and exhaust manifold. Lift gasket from carburetor.

138. DISASSEMBLY OF CARBURETOR.

a. Equipment.

PLIERS
SCREWDRIVER
WRENCH, open-end, ⅝-in.

b. Procedure (fig. 189).

(1) Remove main nozzle and bowl lock plug and outside gasket (⅝-in. open-end wrench).

(2) Lift float bowl from body, and lift main nozzle and bowl lock plug inside gasket, from bowl.

(3) Lift float bowl gasket from body.

(4) Pull float lever shaft from carburetor body (pliers).

(5) Lift float from carburetor body.

(6) Remove float lever screw and washer from float (screwdriver). Lift float lever from float (fig. 190).

(7) Turn body over. Float valve will fall from float valve seat (fig. 190).

(8) Remove float valve seat and gasket (screwdriver) (fig. 190).

(9) Remove main nozzle assembly and gasket from body (screwdriver) (fig. 190).

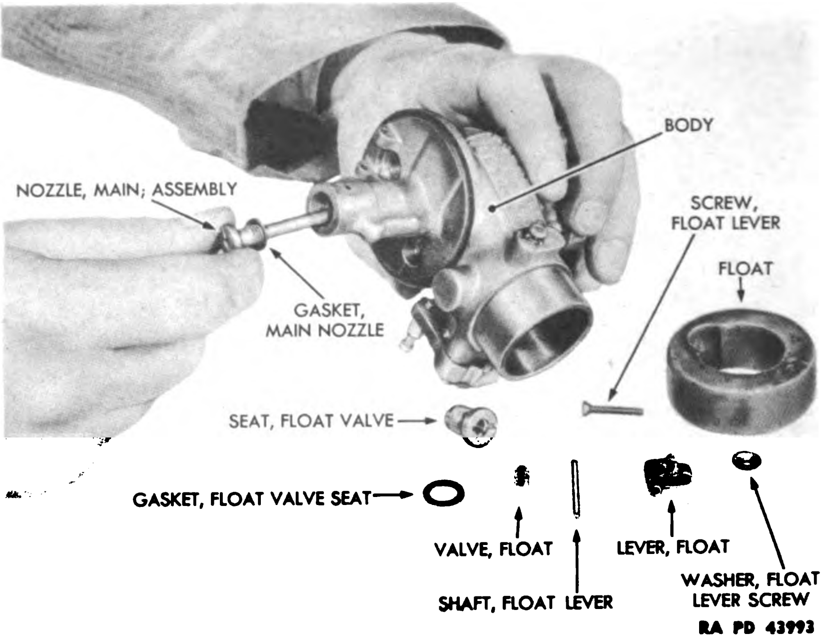

Figure 190 — Removing Carburetor Main Nozzle Assembly

(10) Loosen clamp screw in auxiliary governor throttle lever clamp (screwdriver), and lift clamp from throttle shaft. Lift auxiliary governor throttle lever from throttle shaft (fig. 191).

(11) Loosen throttle lever clamp screw (screwdriver) and lift throttle lever from shaft (fig. 191).

(12) Remove throttle valve screw and lock washer (screwdriver). Pull throttle valve (pliers) from slot in shaft (fig. 191).

(13) Slide throttle shaft assembly from body (fig. 191).

(14) Loosen carburetor choke valve lever clamp screw (screwdriver), and remove lever from choke valve shaft (fig. 192).

(15) Remove cotter pin securing choke valve swivel to choke valve lever, and lift swivel from lever (pliers) (fig. 194).

(16) Remove screws and lock washers securing choke valve to choke valve shaft, and remove valve (screwdriver). Remove pin (hairpin type) from end of choke valve shaft, and slide choke valve shaft from carburetor body (pliers) (fig. 194).

(17) Remove Venturi lock screw from top front portion of carburetor body, and pull Venturi from body (screwdriver) (fig. 193).

139. INSPECTION OF CARBURETOR.

a. Equipment.

COMPRESSED AIR
PRUSSIAN BLUE
SOLVENT, dry-cleaning

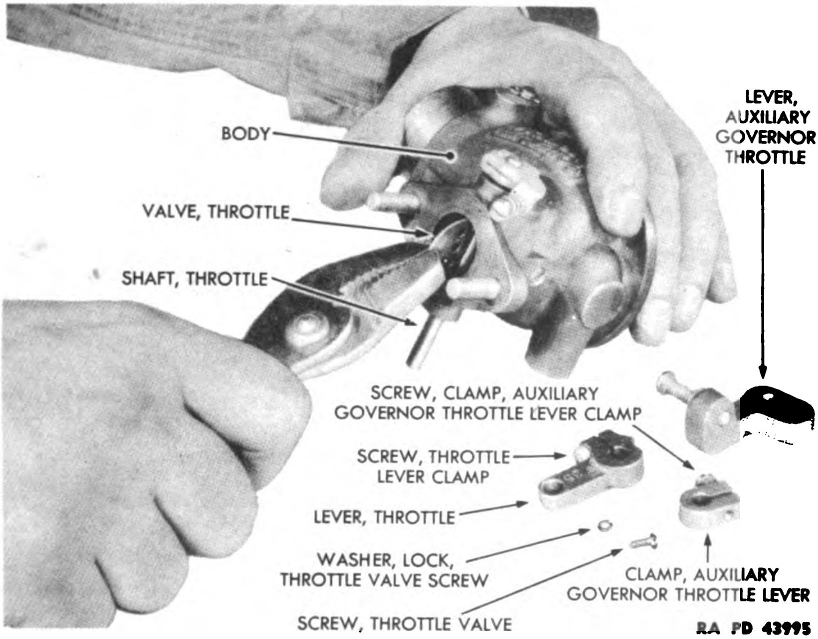

Figure 191 — Removing Carburetor Throttle Valve

b. Procedure.

(1) Clean all parts, except float, in **SOLVENT**, dry-cleaning. Blow dry with compressed air.

(2) Put a little **PRUSSIAN BLUE** on float valve. Insert valve in float valve seat. Give valve a complete turn with the fingers. Remove valve and observe valve seat. **PRUSSIAN BLUE** on seat must show complete seating all the way around if valve and seat are to be used again.

(3) Inspect main nozzle to see that orifices are unobstructed. One main hole runs the length of the nozzle. Three small holes enter the main orifice from side of nozzle.

(4) Examine float for breaks in varnish.

(5) Examine carburetor body to see if broken, or if choke valve stop pin and throttle stop pin are damaged or out of place. See that holes through which gasoline passes from float bowl to nozzle are unobstructed. Blow compressed air through orifice from bottom of body to inside of body near choke valve position to make sure it is unobstructed.

(6) Examine shafts, levers, and valves to see if they are worn or broken. Examine other metal parts to see if broken.

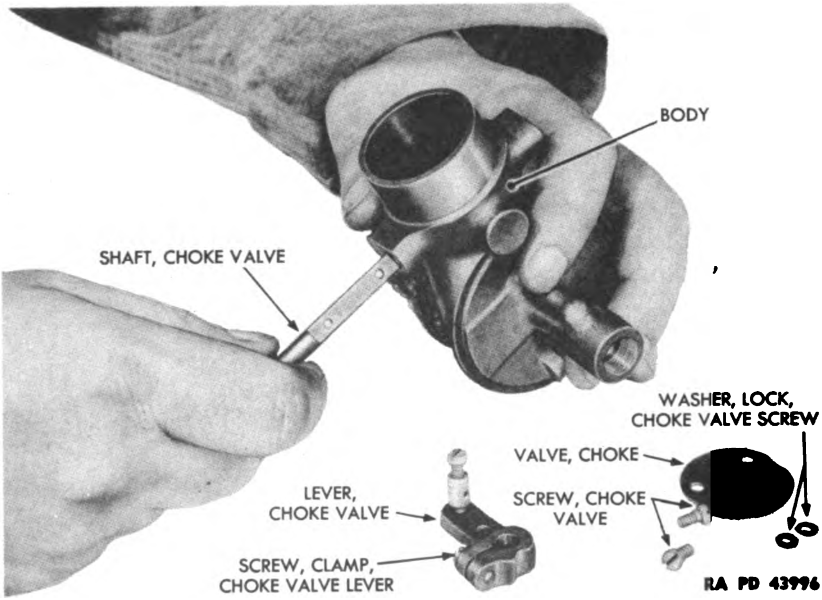

Figure 192 — Removing Carburetor Choke Valve Shaft

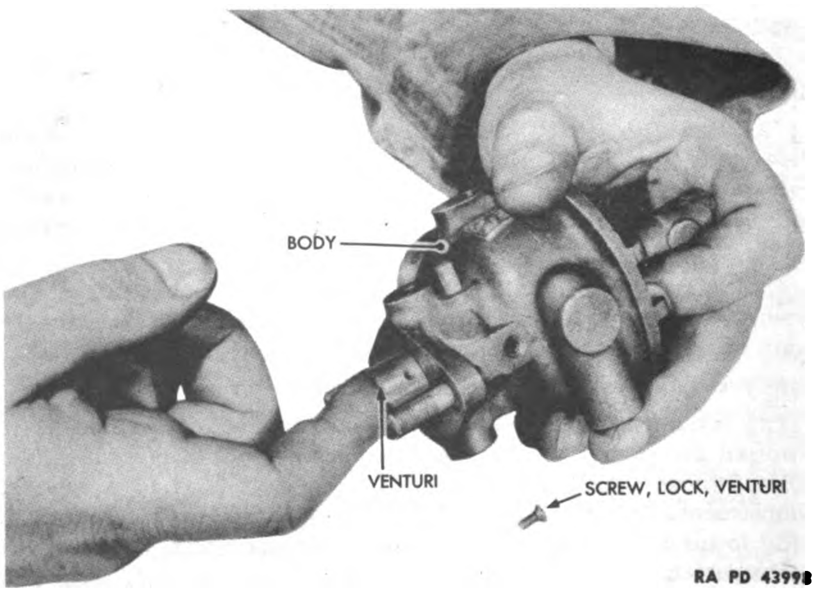

Figure 193 — Removing Carburetor Venturi

140. MAINTENANCE AND REPAIR OF CARBURETOR

a. Equipment.

COMPOUND, valve grinding (fine)
PRUSSIAN BLUE
SOLVENT, dry-cleaning

b. Procedure.

(1) GENERAL.

The only satisfactory repair of carburetor consists of cleaning all metal parts and replacing worn parts. Replace all gaskets each time carburetor is disassembled.

(2) FLOAT.

If varnish is damaged on float, replace float. A saturated float cannot be satisfactorily reclaimed.

(3) FLOAT NEEDLE VALVE.

COMPOUND, valve grinding (fine)
PRUSSIAN BLUE
SOLVENT, dry-cleaning

(a) Replace float needle valve and seat if these parts do not seat airtight. In case of needle valve failure when replacement parts are not available, a temporary repair can be made as follows:

1. Place a little fine valve grinding compound on float needle valve.

2. Insert valve into seat. Oscillate valve a few times.

3. Remove valve from seat, and clean valve and seat with SOLVENT, dry-cleaning.

4. Test fit of valve in its seat with Prussian blue (par. 139 (2)).

5. Repeat substeps *1* through *4* above until a satisfactory seat is obtained. NOTE: At best, this is only a temporary repair and must not be used if replacement parts are available.

141. ASSEMBLY OF CARBURETOR.

a. Equipment.

PLIERS
SCREWDRIVER
WRENCH, open-end, $^{11}/_{16}$-in.

b. Procedure (fig. 194).

(1) Insert Venturi in carburetor body so tapped hole in Venturi lines up with screw hole in body. Install Venturi lock screw (screwdriver).

(2) Insert throttle shaft assembly in carburetor body from throttle stop pin side of body. Insert throttle valve in slot in shaft so beveled edges meet body squarely. Secure throttle valve with screw and lock washer (screwdriver).

(3) Slide throttle lever on throttle shaft so lever is upright with valve open. Tighten clamp screw (screwdriver). Slide auxiliary governor throttle lever and lever clamp in position on throttle lever shaft and tighten clamp screw (screwdriver).

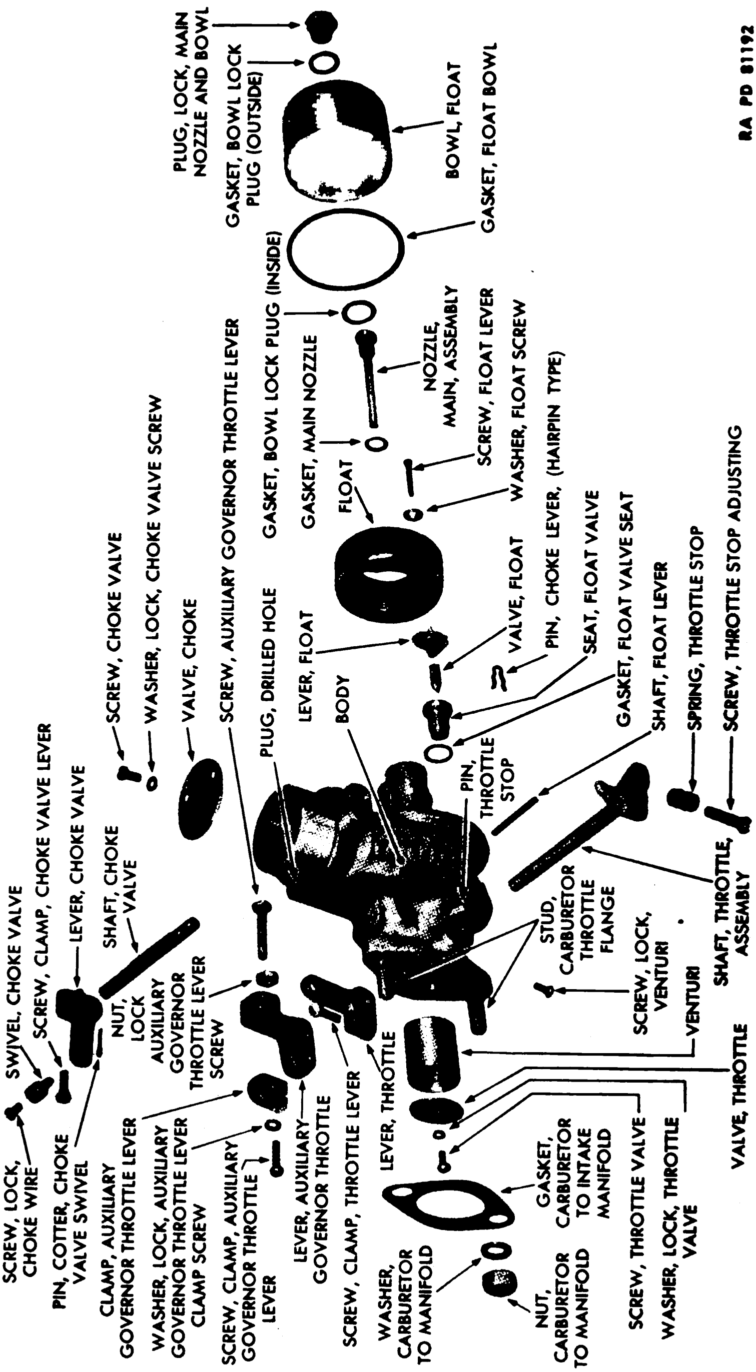

Figure 194 — Carburetor Assembly — Exploded View

FUEL SYSTEM

(4) Slide choke valve shaft into body so pin groove on shaft is on the side of the body bearing the name "Schebler." Install pin (hairpin type).

(5) Lay choke valve on shaft inside body so screw holes in valve line up with screw holes in shaft. Install screws and lock washers (screwdriver). Check action of valve. If properly installed, it will open and close freely.

(6) Slide choke valve lever on choke valve shaft so lever points up when valve is open. Tighten clamp screw (screwdriver). Assemble choke valve swivel to choke valve lever and secure with cotter pin (pliers) (fig. 194).

(7) Using a new main nozzle gasket, screw main nozzle assembly into body and tighten securely (screwdriver).

(8) Using a new float valve seat gasket, screw float valve seat into body and tighten securely (screwdriver).

(9) Carefully install float valve into float valve seat, pointed end first.

(10) Install float lever to float with screw and washer (screwdriver). Tighten until snug. Do not compress cork.

(11) Place float assembly in position on body, and insert float lever shaft.

(12) Using a new bowl gasket (top end) and a new bowl lock plug gasket (inside), place float bowl in position on body. Using a new bowl lock plug gasket (outside), install main nozzle and bowl lock plug ($1\frac{1}{16}$-in. open-end wrench).

142. INSTALLATION OF CARBURETOR.

a. Equipment.

PLIERS
WRENCH, open-end, $\frac{7}{16}$-in.
WRENCH, open-end, $\frac{5}{16}$-in.

b. Procedure.

(1) Using a new carburetor to intake manifold gasket, place carburetor in position on intake and exhaust manifold (fig. 188).

(2) Install throttle flange stud lock washers and nuts ($\frac{7}{16}$-in. open-end wrench) (fig. 188).

(3) Connect auxiliary governor connecting rod to throttle lever ($\frac{5}{16}$-in. open-end wrench) (fig. 188).

(4) Place governor connecting rod in position on throttle lever, and install governor connecting rod cotter pin (pliers) (fig. 188).

(5) Install gasoline strainer (par. 155).

(6) Install air cleaner (par. 136).

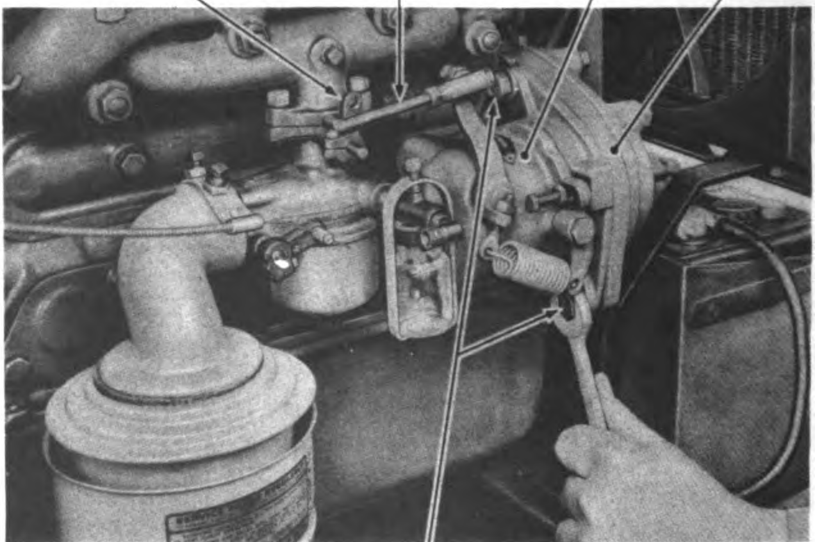

Figure 195 — Removing Governor

143. REMOVAL OF GOVERNOR.

a. Equipment.

PLIERS	WRENCH, open-end, ⅝-in.

b. Procedure (fig. 195).

(1) Remove governor connecting rod cotter pin from governor connecting rod (pliers). Pull rod from throttle lever.

(2) Remove governor attaching screws and lock washers (⅝-in. open-end wrench).

(3) Lift governor from cylinder block. Remove governor attaching gasket from governor or cylinder block.

144. DISASSEMBLY OF GOVERNOR (fig. 200).

a. Equipment.

DRIFT	PUNCH, ⅜-in.
GRINDER	PUNCH, 15⁄32-in.
HAMMER	SCREWDRIVER
MALLET	WRENCH, open-end, ⅜-in.
PRESS, arbor	WRENCH, open-end, 7⁄16-in.
PUNCH, ⅛-in.	WRENCH, socket, 5⁄16-in.

b. Procedure.

(1) Remove surge screw lock nut (Z) and washer (AA), and

FUEL SYSTEM

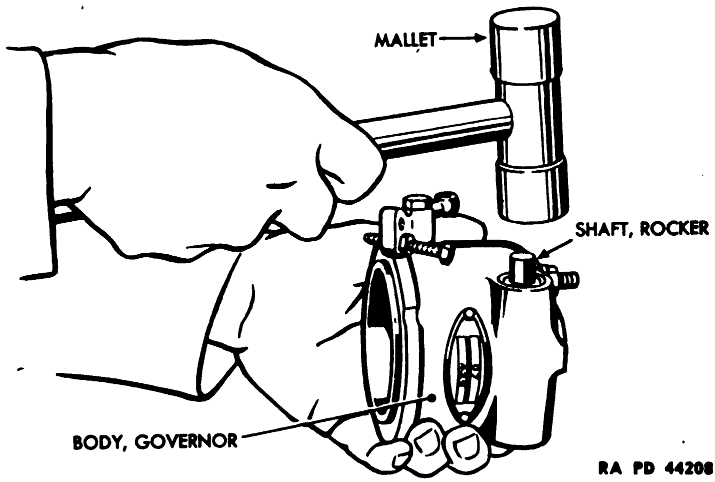

Figure 196 — Driving Rocker Shaft from Governor Body

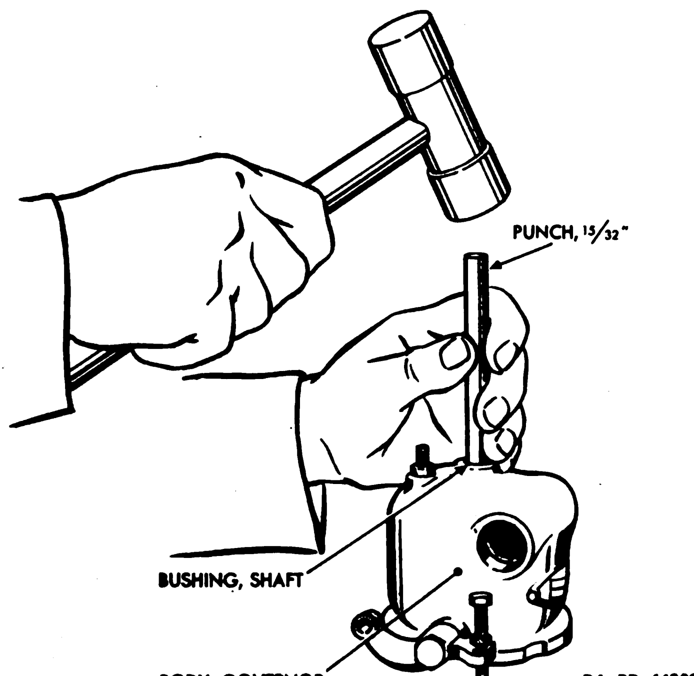

Figure 197 — Driving Shaft Bushing from Governor Body

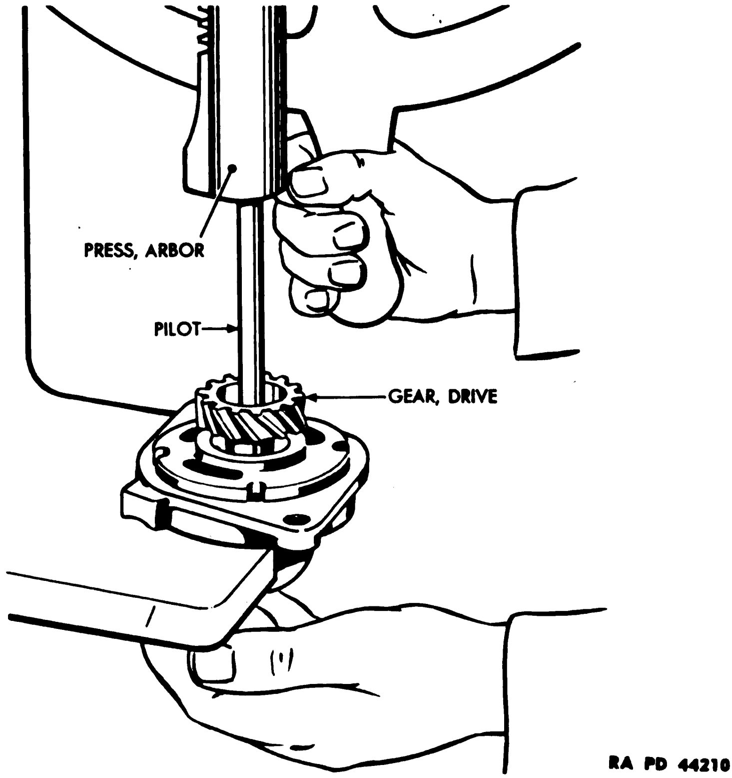

Figure 198 — Pressing Governor Drive Shaft from Drive Gear

unscrew surge adjusting screw (BB) (7/16-in. open-end wrench). Lift off surge adjusting spring (CC).

(2) Unscrew governor adjusting lever pin (A) and remove adjusting lever (W) and spring (V) (7/16-in. open-end wrench).

(3) Remove spring adjusting nut (L) and adjusting screw (N) (3/8-in. open-end wrench).

(4) Remove flange to body screws (AF) and lock washers (AE) from governor, and remove flange (ZZ) from body (FF) (screwdriver). Remove body gasket.

(5) Drive out pin (S) from throttle lever (M) and remove lever from rocker shaft (Y) (1/8-in. punch and hammer).

(6) Remove cap screws (KK) and lock washers (JJ) securing rocker yoke (HH) and lift out yoke (5/16-in. open-end wrench).

(7) Drive out rocker shaft (Y) (mallet) (fig. 196). This operation will automatically remove rocker shaft bearing (R) and expansion plug (GG). Remove bearing from shaft.

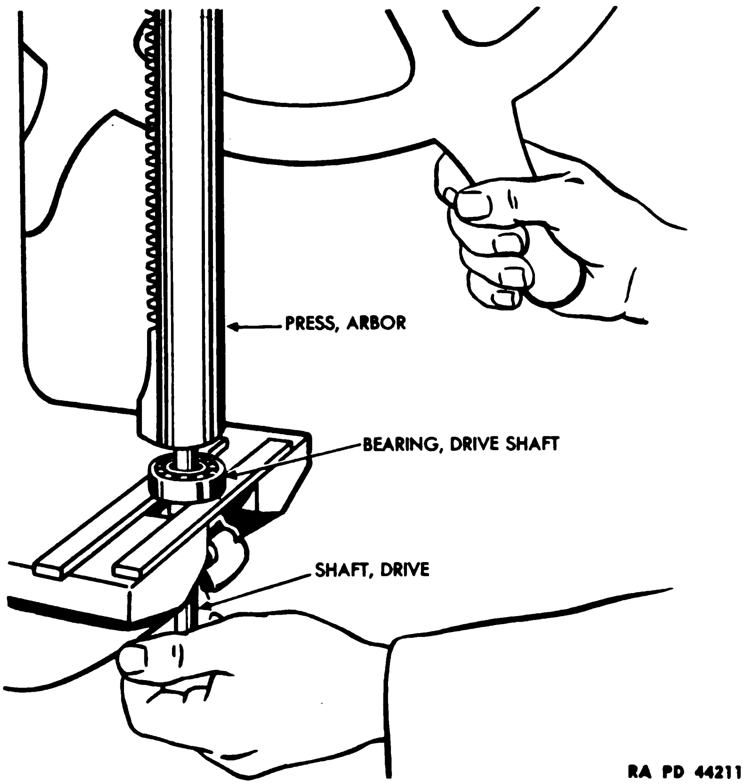

Figure 199 — Pressing Governor Drive Shaft Bearing from Drive Shaft

(8) Reverse the shaft and insert through plug hole in body and into other bearing. Drive out bearing (R), bearing retainer (P), and bearing oil retainer (Q) (mallet).

(9) Remove rocker shaft snap rings (X) from rocker shaft (Y).

(10) Knock out drive shaft expansion plug (DD) from end of body (drift and hammer).

(11) Drive shaft bushing (EE) from body ($^{15}/_{32}$-in. punch and hammer).

(12) Remove thrust bearing (LL) and sleeve (MM) from drive shaft (SS).

(13) Drive out pin (AD) securing gear (AC) to drive shaft (SS) ($^{1}/_{8}$-in. punch and hammer).

(14) Remove bearing retainer screws (TT) and lock washers (UU) from flange (ZZ) (screwdriver).

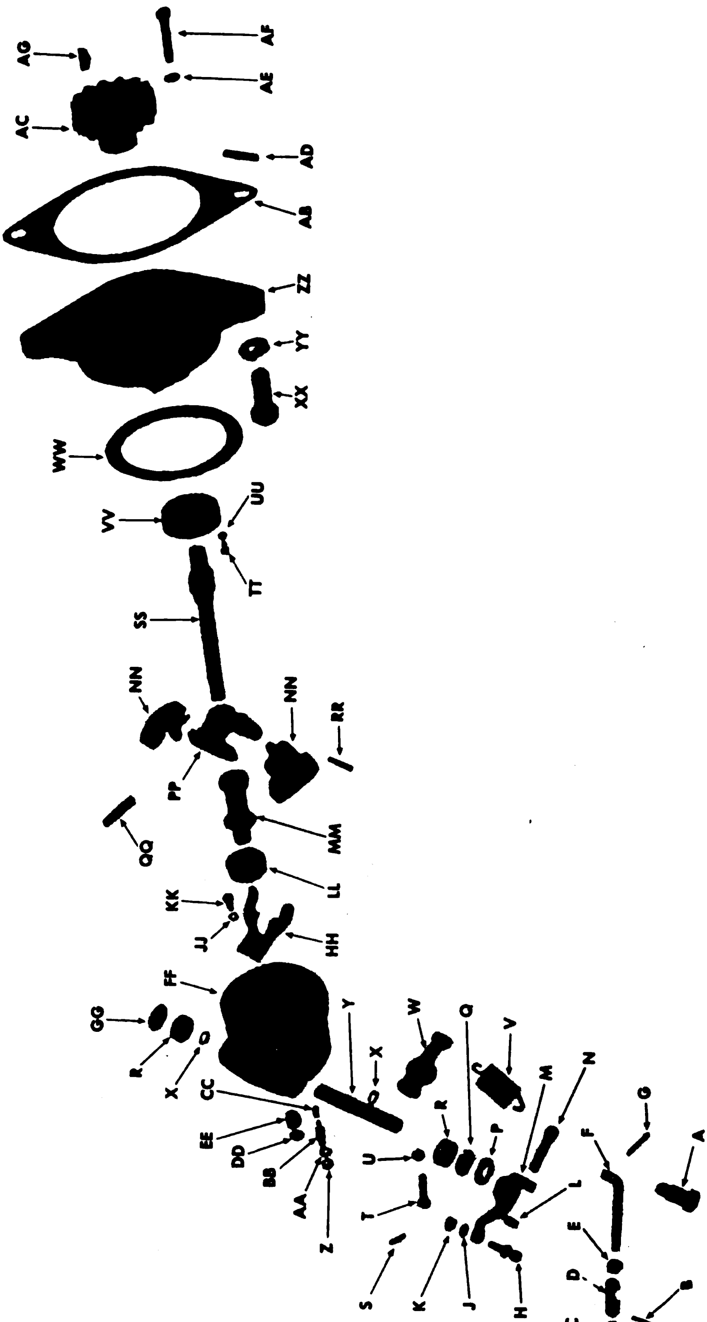

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Figure 200 — Governor Assembly — Exploded View

A—PIN, GOVERNOR ADJUSTING LEVER
B—PIN, COTTER, GOVERNOR CONNECTING ROD BALL JOINT PLUG
C—PLUG, GOVERNOR CONNECTING ROD BALL JOINT
D—CASE, GOVERNOR CONNECTING ROD BALL JOINT
E—NUT, LOCK, GOVERNOR CONNECTING ROD
F—ROD, CONNECTING
G—PIN, COTTER, GOVERNOR CONNECTING ROD
H—JOINT, BALL, GOVERNOR CONNECTING ROD
J—WASHER, LOCK, GOVERNOR CONNECTING ROD BALL JOINT
K—NUT, GOVERNOR CONNECTING ROD BALL JOINT
L—NUT, GOVERNOR SPRING ADJUSTING SCREW
M—LEVER, GOVERNOR THROTTLE
N—SCREW, GOVERNOR SPRING ADJUSTING
P—RETAINER, GOVERNOR BEARING
Q—RETAINER, GOVERNOR BEARING OIL
R—BEARING, GOVERNOR ROCKER SHAFT
S—PIN, GOVERNOR YOKE AND LEVER
T—SCREW, GOVERNOR ADJUSTING
U—NUT, GOVERNOR ADJUSTING SCREW
V—SPRING, GOVERNOR
W—LEVER, GOVERNOR ADJUSTING
X—RING, SNAP, GOVERNOR ROCKER SHAFT
Y—SHAFT, GOVERNOR ROCKER
Z—NUT, LOCK, GOVERNOR SURGE ADJUSTING SCREW
AA—WASHER, GOVERNOR SURGE ADJUSTING SCREW
BB—SCREW, GOVERNOR SURGE ADJUSTING
CC—SPRING, GOVERNOR SURGE ADJUSTING
DD—PLUG, EXPANSION, GOVERNOR DRIVE SHAFT
EE—BUSHING, GOVERNOR DRIVE SHAFT
FF—BODY, GOVERNOR
GG—PLUG, EXPANSION, GOVERNOR ROCKER SHAFT
HH—YOKE, ROCKER, GOVERNOR
JJ—WASHER, LOCK, GOVERNOR ROCKER YOKE
KK—SCREW, GOVERNOR ROCKER YOKE
LL—BEARING, THRUST, GOVERNOR
MM—SLEEVE, THRUST, GOVERNOR
NN—WEIGHT, GOVERNOR
PP—SPIDER, GOVERNOR WEIGHT
QQ—PIN, GOVERNOR WEIGHT
RR—PIN, GOVERNOR SPIDER
SS—SHAFT, DRIVE, GOVERNOR
TT—SCREW, GOVERNOR BEARING RETAINER
UU—WASHER, LOCK, GOVERNOR BEARING RETAINER SCREW
VV—BEARING, GOVERNOR DRIVE SHAFT
WW—GASKET, GOVERNOR BODY
XX—SCREW, GOVERNOR ATTACHING
YY—WASHER, LOCK, GOVERNOR ATTACHING SCREW
ZZ—FLANGE, GOVERNOR BODY
AB—GASKET, GOVERNOR TO CYLINDER BLOCK
AC—GEAR, GOVERNOR DRIVE
AD—PIN, GOVERNOR DRIVE GEAR
AE—WASHER, LOCK, GOVERNOR CASE SCREW
AF—SCREW, GOVERNOR CASE
AG—KEY, GOVERNOR DRIVE SHAFT GEAR

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Legend for Figure 200 — Governor Assembly — Exploded View

(15) Press shaft (SS) from gear (AC), catching shaft and weight assembly as they are pressed free, to avoid damaging them (3/8-in. punch and arbor press).

(16) Remove drive shaft gear key (AG) and press bearing (VV) from drive shaft (arbor press) (fig. 199).

(17) Grind off riveted end of weight pins (QQ) and drive pins from weights (NN) and spider (PP) (grinder, 3/8-in. punch, and hammer.)

(18) Drive spider pin (RR) from spider (PP) and shaft (SS), and press spider from shaft (1/8-in. punch, hammer, and arbor press).

145. INSPECTION AND REPAIR OF GOVERNOR.

a. Equipment.

CLOTH, crocus
CLOTH, wiping
COMPRESSED AIR
FILE, 3-cornered
SOLVENT, dry-cleaning
TAP, thread

b. Procedure.

(1) Wash all parts in SOLVENT, dry-cleaning. Dry with compressed air.

(2) Examine all screws, nuts, washers, pins. levers, and connecting rod parts to see if any are broken or have damaged threads. Remove burs with fine, 3-cornered file or thread tap. Replace parts having threads stripped.

(3) Inspect governor spring. If broken, worn, or bent, replace.

(4) Inspect governor body and body flange. Replace if broken.

(5) Examine all bearings to see if any are worn or contain foreign matter. The thrust bearing on the thrust sleeve shows wear by looseness between top thrust surface and opposite race; replace if worn sufficiently to cause looseness. The drive shaft bearing is unsatisfactory for further use if rough spots can be detected when rotating it with the thumb and finger, or if races are loose enough to indicate wear.

(6) Examine governor weights to see if weight noses which bear on the thrust sleeve are worn or flattened. Replace if these conditions exist.

(7) Inspect governor drive shaft bushing to see if it is worn, broken, or scored.

(8) Inspect governor drive shaft to see if it is broken, scored, or worn. If the governor drive shaft is only slightly scored where it revolves in the bushing, polish shaft with CLOTH, crocus. Wipe shaft with CLOTH, wiping. If shaft is more than slightly scored, use a new part.

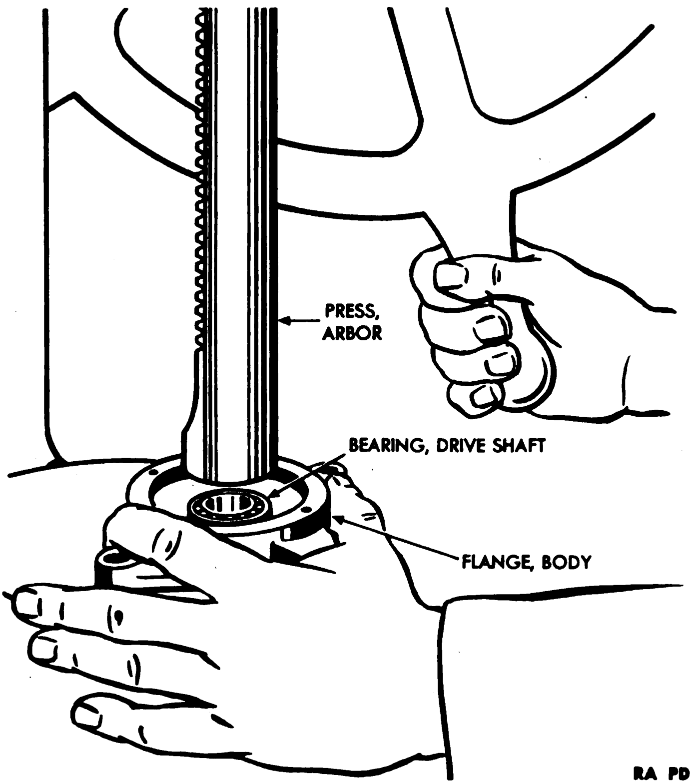

Figure 201 — Pressing Governor Drive Shaft Bearing into Body Flange

146. ASSEMBLY OF GOVERNOR (fig. 200).

a. Equipment.

DRILL, electric (1/8-in. bit)	SCALE, spring
DRIVER, special (2)	SCALE, steel
HAMMER	SCREWDRIVER
MALLET	VISE
PLIERS	WRENCH, open-end, 3/8-in.
PRESS, arbor	WRENCH, open-end, 7/16-in.
PUNCH, 3/8-in.	WRENCH, socket, 5/16-in.
REAMER, taper (No. 1 Morse)	

b. Procedure.

(1) Press weight spider (PP) in position on drive shaft (SS) and secure with spider pin (RR) (arbor press, 1/8-in. punch, and hammer). NOTE: If new spider and shaft is used, drill through spider and shaft (1/8-in. drill).

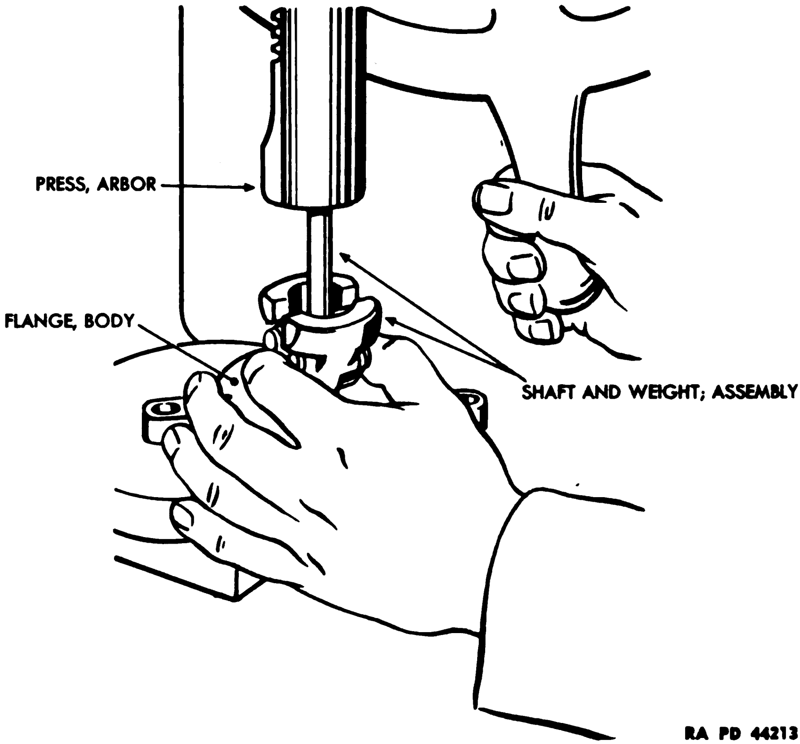

Figure 202 — Pressing Shaft and Weight Assembly Into Governor Drive Shaft Bearing

(2) Assemble weights (NN) to spider (PP) and assemble new weight pins (QQ) to weights and spider. Peen over ends of weight pins (hammer).

(3) Press bearing (VV) into body flange (ZZ) (arbor press) (fig. 201), and install bearing retaining screws (TT) and lock washers (UU) (screwdriver).

(4) Press shaft and weight assembly into bearing (VV), using short interrupted strokes with the arbor to aline shaft and bearing (arbor press) (fig. 202). NOTE: Use extreme care during this operation, because if shaft is sprung out of line, it will affect governor operation.

(5) Insert key (AG) in shaft. Line up keyway in gear with key in shaft, and press gear (AC) on shaft (arbor press). Assemble pin (AD) to gear and shaft (3/8-in. punch and hammer).

(6) Assemble thrust sleeve (MM) and thrust bearing (LL) to shaft.

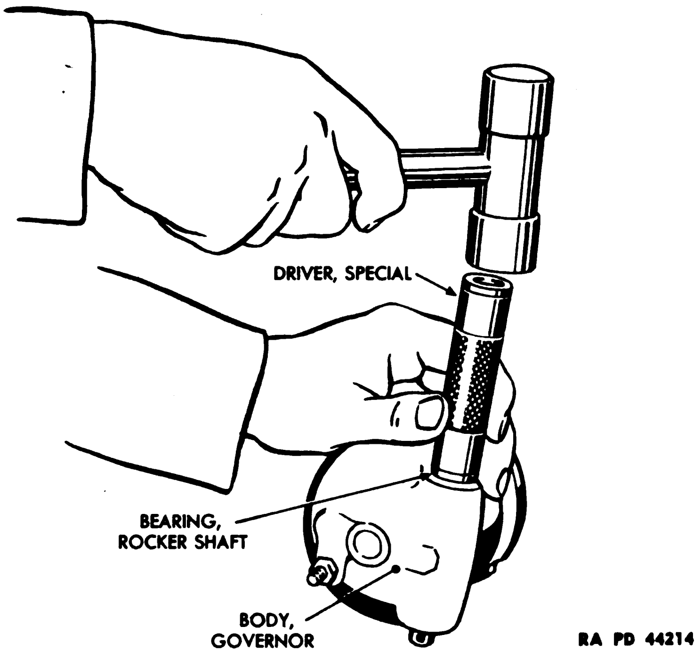

Figure 203 — Installing Governor Rocker Shaft Bearing

(7) Assemble bushing (EE) to body, using special driver (fig. 227). Tap bushing into position with mallet so shoulder of tool is flush with body. NOTE: This bushing must be lined up so it does not bind the drive shaft.

(8) Assemble new drive shaft expansion plug (DD) to body (hammer).

(9) Install rocker shaft snap rings (X) on rocker shaft (Y) and place shaft in body.

(10) Assemble yoke (HH) to rocker shaft with two cap screws (KK) and lock washers (JJ) ($\frac{5}{16}$-in. socket wrench).

(11) Place rocker shaft bearings (R) on shaft with lettered side toward yoke.

(12) Tap bearings into place with special driver (fig. 228) and mallet (fig. 203).

(13) Assemble oil retainer (Q) and bearing retainer (P) over shaft with convex side out. Set in place with special tool (fig. 228). NOTE: Do not force oil seal on shaft so tight it will cause excessive friction. Rocker shaft must rotate freely.

(14) Install rocker shaft expansion plug (GG) (hammer).

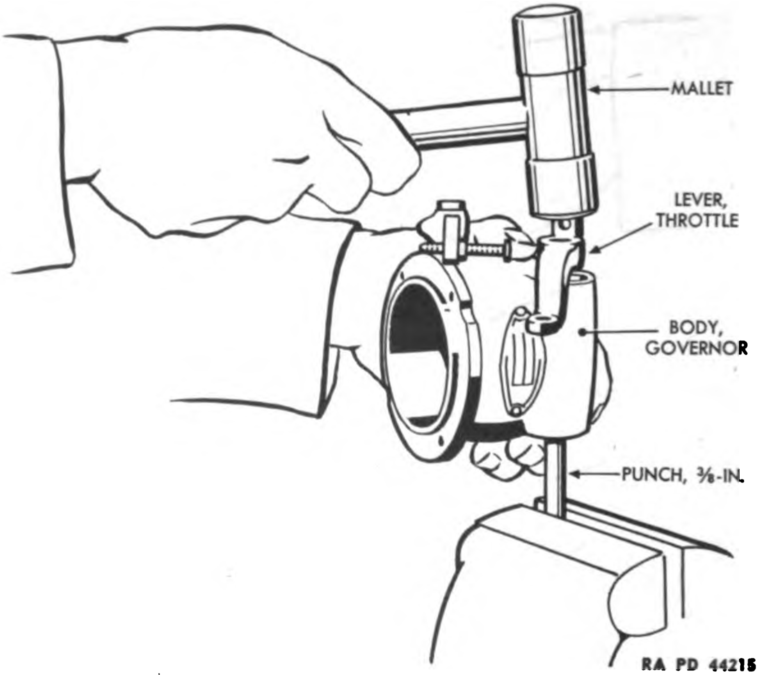

Figure 204 — Installing Governor Throttle Lever

(15) Assemble throttle lever (M) to rocker shaft (X). NOTE: When tapping lever on shaft, back up shaft with a 3/8-inch punch to avoid damage to bearings (vise, 3/8-in. punch, and hammer) (fig. 204).

(16) Check rocker shaft for freedom of operation. Not more than a 3-ounce pull on the end of the lever should be necessary to rotate rocker shaft (spring scale).

(17) Assemble body and flange, using a new gasket (WW), by installing four screws (AF) and lock washers (AE).

(18) Hold governor vertically so weights are closed, and then rotate throttle lever (M) away from gear until yoke contacts thrust bearing inside body.

(19) Advance lever from this position, in the same direction, until center of the lever hole measures 3 7/16 inches from the body flange (steel scale) (fig. 205).

(20) Drill 1/8-inch hole through lever and shaft, and ream for No. 1 taper pin. Install pin (electric drill, 1/8-in. bit, and No. 1 Morse taper reamer).

(21) Assemble spring adjusting screw (N) on throttle lever (M) and lock with spring adjusting screw nut (L) (3/8-in. open-end wrench).

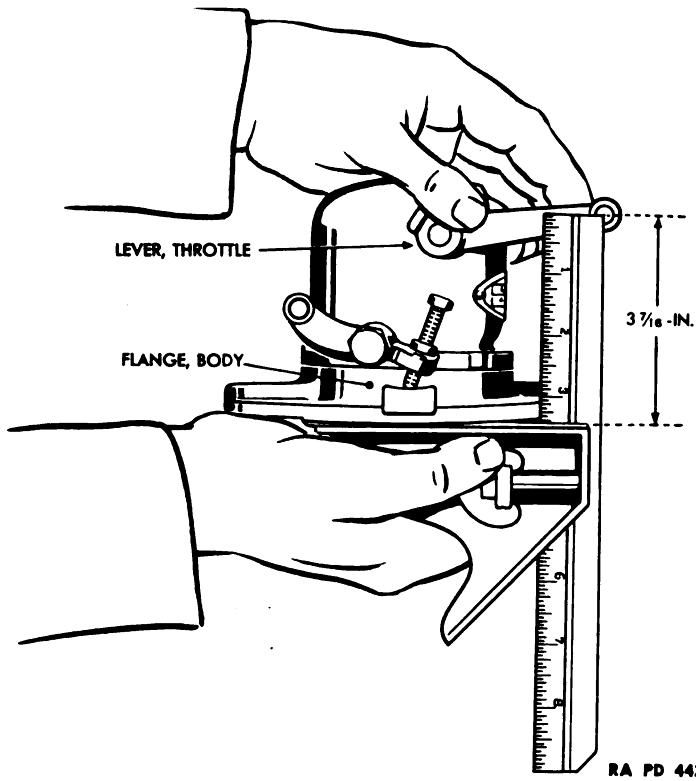

Figure 205 — Setting Governor Throttle Lever

(22) Install adjusting lever in position on governor body with adjusting lever pin (A) (7/16-in. open-wrench). Install spring by hooking one end through eye of adjusting screw (N) and the other end through hole in adjusting lever (W).

(23) Assemble surge spring (CC) and surge adjusting screw (BB) on body, and secure with lock nut (Z) and washer (AA).

147. INSTALLATION OF GOVERNOR.

a. Equipment.

PLIERS WRENCH, open-end, 5/8-in.

b. Procedure.

(1) Using a new governor attaching gasket, place governor in position on cylinder block (fig. 195).

(2) Install lock washers and cap screws (5/8-in. open-end wrench) (fig. 195).

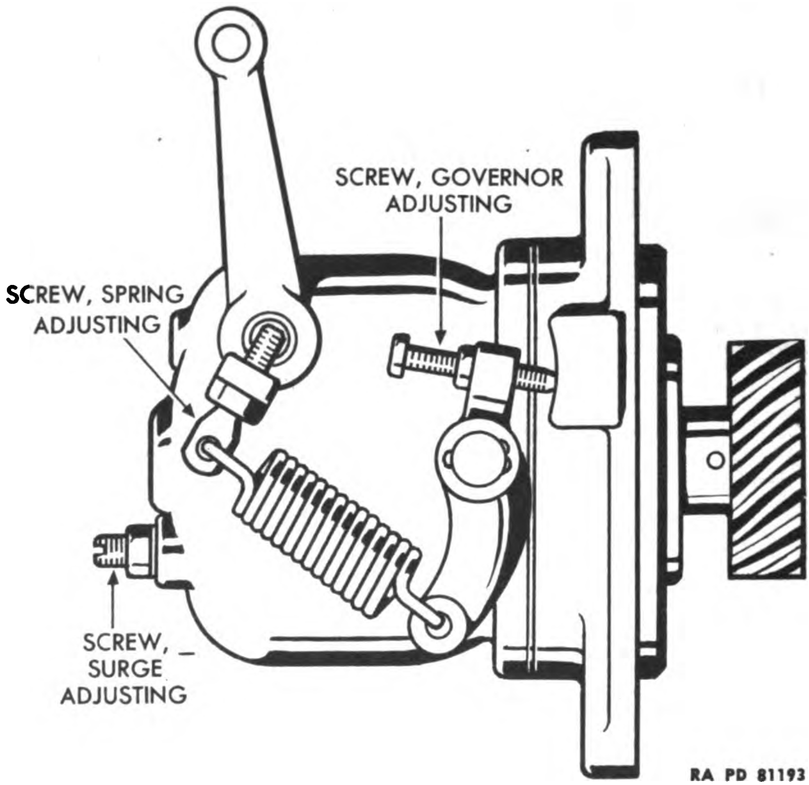

Figure 206 — Governor Adjusting Diagram

(3) Place governor connecting rod in position on throttle lever. Install cotter pin (pliers) (fig. 195).

148. ADJUSTMENT OF GOVERNOR.

a. Equipment.

PLIERS
SCREWDRIVER
WRENCH, open-end, ¼-in.
WRENCH, open-end, ⅜-in.
WRENCH, open-end, 7/16-in.

b. Procedure (fig. 206).

(1) Loosen surge adjusting screw lock nut (7/16-in. open-end wrench).

(2) Back surge adjusting screw from governor until only a few threads are engaged (screwdriver).

(3) Tighten surge adjusting screw lock nut (7/16-in. open-end wrench).

FUEL SYSTEM

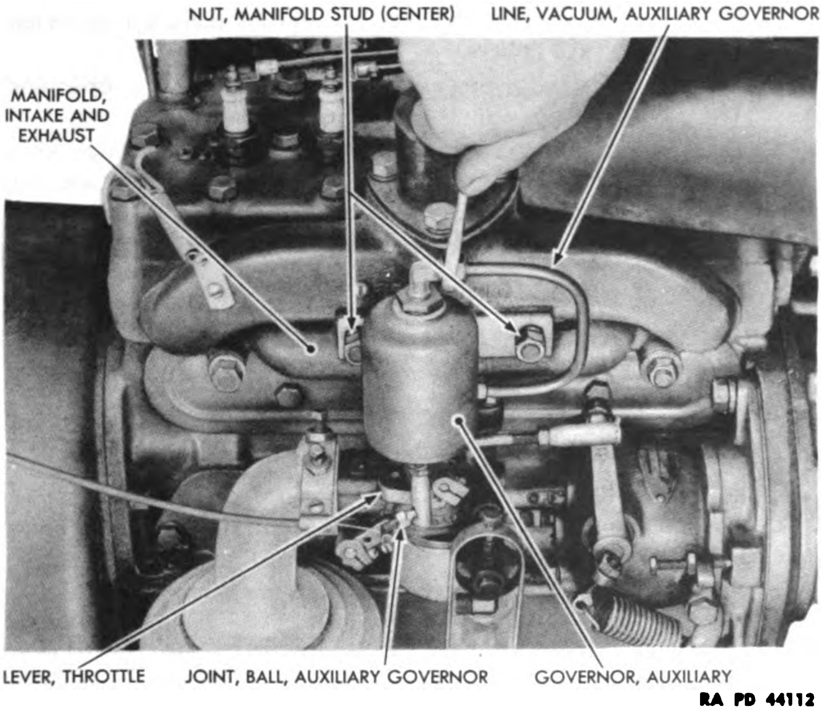

Figure 207 — Removing Auxiliary Governor

(4) Loosen governor adjusting screw lock nut (7/16-in. open-end wrench).

(5) Start engine and adjust engine speed by turning governor adjusting screw in or out (3/8-in. open-end wrench). Turning screw clockwise increases engine speed. Turning screw counterclockwise decreases engine speed. Engine speed is correct when frequency meter shows 50 or 60 cycles, depending on change-over panel adjustment. Stop engine.

(6) Adjust governor sensitivity, if necessary, as follows:

(a) Remove governor spring from governor spring adjusting screw (pliers).

(b) Loosen governor spring adjusting screw lock nut (7/16-in. open-end wrench).

(c) Turn governor spring adjusting screw in or out (1/4-in. open-end wrench). Moving spring hook closer to the rocker shaft, decreasing effective length of screw, increases governor sensitivity. Moving spring away from shaft broadens sensitivity. Use shortest screw length possible without causing surging of the governor.

(d) Tighten governor spring adjusting screw lock nut (7/16-in. open-end wrench).

(e) Hook end of governor spring into spring hook on governor spring adjusting screw (pliers).

(7) Loosen surge adjusting screw lock nut (7/16-in. open-end wrench).

(8) Start engine and turn surge adjusting screw clockwise until no-load surge is dampened out (screwdriver). CAUTION: Do not turn it far enough to increase no-load engine speed.

(9) Tighten surge adjusting screw lock nut (7/16-in. open-end wrench).

149. REMOVAL OF AUXILIARY GOVERNOR (UNIT M6).

a. Equipment.

PLIERS	WRENCH, open-end, 9/16-in.
WRENCH, open-end, ½-in.	

b. Procedure (fig. 207).

(1) Disconnect auxiliary governor ball joint from throttle lever (pliers).

(2) Disconnect auxiliary governor vacuum line from manifold and auxiliary governor (½-in. open-end wrench).

(3) Remove center manifold stud nuts (9/16-in. open-end wrench).

(4) Lift auxiliary governor from intake and exhaust manifold.

150. DISASSEMBLY OF AUXILIARY GOVERNOR (UNIT M6).

a. Equipment.

PLIERS	WRENCH, open-end, ⅜-in.
SCREWDRIVER	WRENCH, open-end, 11/16-in.

b. Procedure (fig. 208).

(1) Screw vacuum line elbow (A) from bellows housing orifice (B) (⅜-in. open-end wrench) (fig. 208).

(2) Screw bellows housing orifice (B) from bellows housing (D) (11/16-in. open-end wrench) (fig. 208).

(3) Remove support-plate-to-bellows-housing screws (F) (screwdriver). Lift support plate (E) from bellows housing (D) (fig. 208).

(4) Remove base-to-bellows-housing screws (K) and lock washers (J) (screwdriver). Lift bellows and base (H) and gasket (G) from bellows housing (D) (fig. 208).

(5) Loosen ball joint case lock nut (L) (⅜-in. open-end wrench). Remove ball joint case (M) and lock nut (L) from plunger (fig. 208).

(6) Remove ball joint cotter pin (P) from ball joint case (M) (pliers). Screw ball joint plug (R) from ball joint case (M) (screwdriver). Lift ball joint (N) from ball joint case (M) (fig. 208).

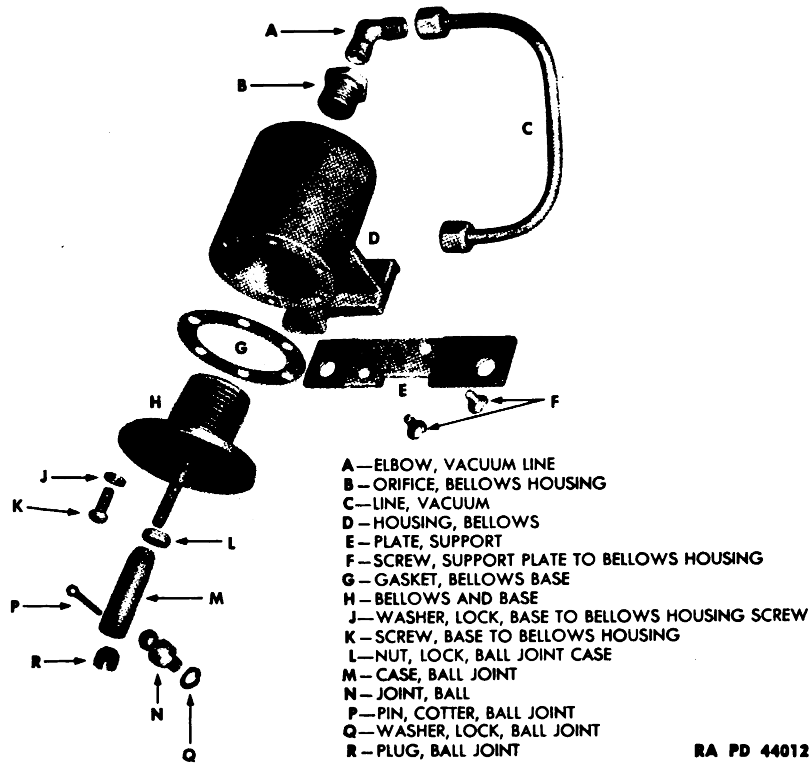

Figure 208 — Auxiliary Governor Assembly Unit M6 — Exploded View

151. INSPECTION AND REPAIR OF AUXILIARY GOVERNOR (UNIT M6).

a. Equipment.

COMPRESSED AIR　　　　SOLVENT, dry-cleaning

b. Procedure.

(1) Clean all parts in SOLVENT, dry-cleaning. Blow dry with compressed air.

(2) Examine vacuum line, elbow, and bellows housing orifice to see if broken, or if threads are damaged. Blow through each to be sure passage is clear. Replace damaged parts.

(3) Inspect bellows housing, base, and support plate to see if cracked or broken. Observe condition of the threads tapped in base-to-bellows-housing screw holes. Replace cracked or broken parts and repair damaged threads. Always replace base gasket when governor is disassembled.

(4) Examine parts of ball joint for breakage or damaged threads. Replace if damaged.

(5) Inspect bellows for breakage. Place bellows to the mouth. With lips against base, attempt to blow and suck through bellows. Replace if leaking.

152. ASSEMBLY OF AUXILIARY GOVERNOR (UNIT M6).

a. Equipment.

LEAD, red
PLIERS
SCREWDRIVER
VARNISH, shellac
WRENCH, open-end, ⅜-in.
WRENCH, open-end, 1 1/16-in.

b. Procedure (fig. 208).

(1) Place ball joint (N) in position in ball joint case (M). Screw ball joint plug (R) into case (M) far enough to stop all side play of ball joint (N) (screwdriver). Do not tighten so ball joint (N) binds in case (M). Install cotter pin (P) through ball joint case (M) and plug (R) (pliers) (fig. 208).

(2) Screw ball joint lock nut (L) about halfway up on threads of bellows plunger. Screw ball joint case (M) up to lock nut (L) on plunger. Tighten lock nut (L) against case (M) (⅜-in. open-end wrench) (fig. 208).

(3) Shellac a new bellows base gasket (G) to bottom of bellows housing (D). Insert bellows (H) into housing (D). Install base-to-bellows-housing screws (K) and lock washers (J) (screwdriver) (fig. 208).

(4) Put a little LEAD, red, on male thread of bellows housing orifice (B). Screw orifice (B) in top of bellows housing (D) (1 1/16-in. open-end wrench). Screw vacuum line elbow (A) in bellows housing orifice (B) (⅜-in. open-end wrench) (fig. 208). Tighten securely, and have elbow pointing to front of auxiliary governor (fig. 216).

(5) Place support plate (E) in position on bellows housing (D), slotted side down. Install screws (F) (screwdriver) (fig. 208).

153. INSTALLATION OF AUXILIARY GOVERNOR (UNIT M6).

a. Equipment.

WRENCH, open,-end, ½-in.
WRENCH, open-end, 9/16-in.
WRENCH, open-end, ⅝-in.

b. Procedure.

(1) Place auxiliary governor in position on manifold studs (fig. 207).

(2) Install manifold stud nuts (9/16-in. open-end wrench) (fig. 207).

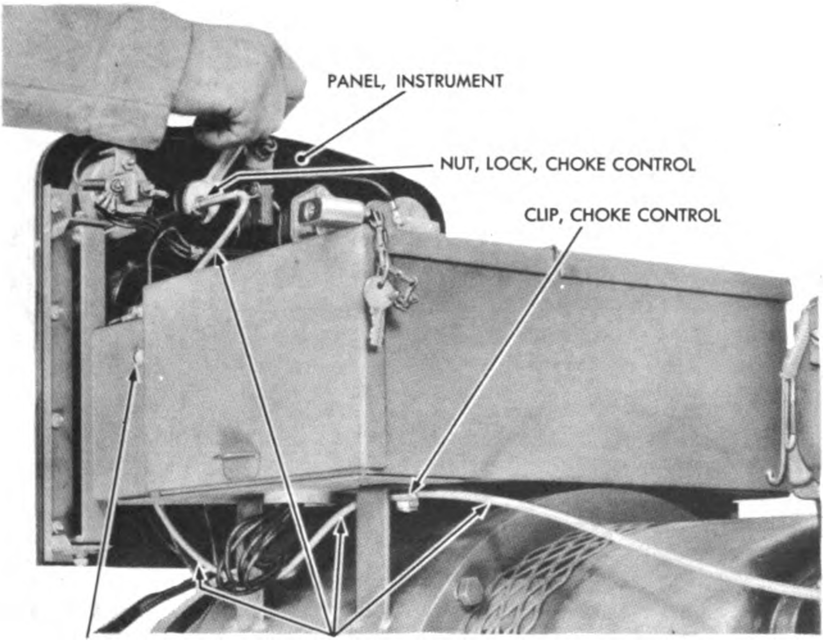

Figure 209 — Removing Choke Control

(3) Connect auxiliary governor vacuum line securely to manifold, and to auxiliary governor (½-in. open-end wrench) (fig. 207).

(4) Connect auxiliary governor ball joint to throttle lever (⅝-in. open-end wrench) (fig. 207).

154. CHOKE CONTROL.

a. Removal.

SCREWDRIVER
WRENCH, open-end, ½-in.
WRENCH, open-end, ⅝-in.

(1) Remove housing (par. 14).

(2) Screw choke control lock nut completely off threads behind switchboard panel (⅝-in. open-end wrench) (fig. 209).

(3) Loosen top switchboard bracket screw (screwdriver), and pull choke control conduit from clamp held by top switchboard bracket screw nut (fig. 209).

(4) Loosen nut beneath change-over panel box, and pull choke control conduit from clip held by nut (½-in. open-end wrench).

(5) Loosen screw which secures choke control conduit to clamp on air cleaner (screwdriver) (fig. 186).

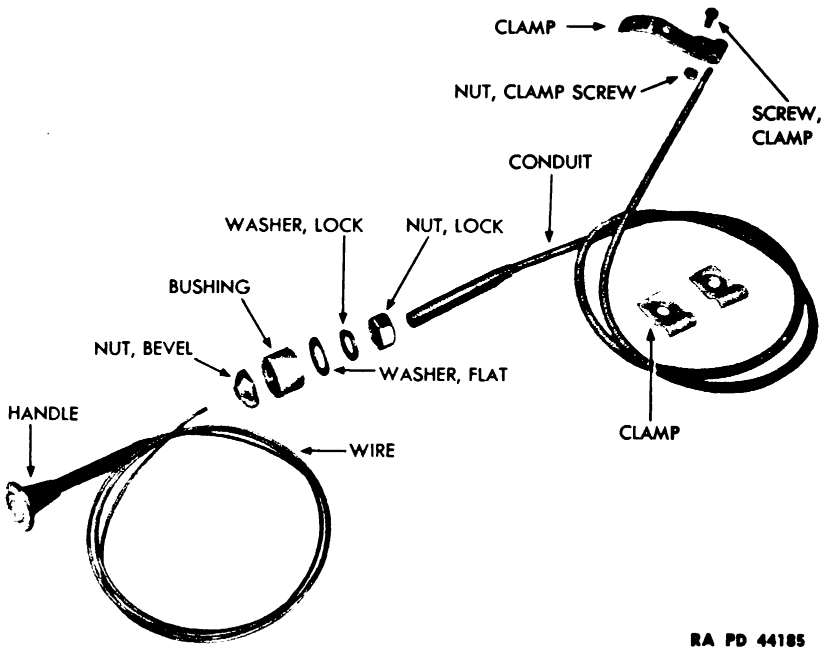

Figure 210 — Choke Control Assembly — Exploded View

(6) Disconnect choke control wire from choke valve lever on carburetor (screwdriver) (fig. 186).

(7) Remove lock nut, lock washer, and flat washer from choke control conduit. Pull choke control assembly out through switchboard panel.

b. Inspection and Repair.

COMPRESSED AIR
GREASE, general purpose, No. 0
SOLVENT, dry-cleaning

(1) Clean all parts of choke control with SOLVENT, dry-cleaning, and dry with compressed air.

(2) Inspect bevel nut, bushing, flat washer, lock washer, lock nut, clips, and bracket. Replace any broken part.

(3) Grasp handle with one hand and conduit with the other. Pull wire from conduit. Inspect handle, wire, and conduit. Replace any broken part. Grease wire and insert it in conduit assembly (GREASE, general purpose, No. 0).

c. Installation.

SCREWDRIVER
WRENCH, open-end, ½-in.
WRENCH, open-end, ⅝-in.

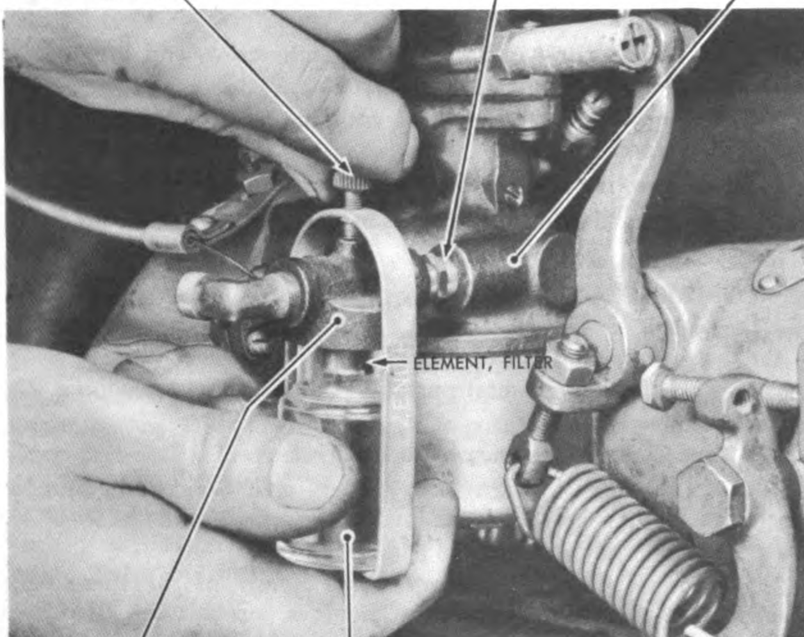

Figure 211 — Removing Gasoline Strainer

(1) Thread carburetor end of choke control through switchboard panel from rear of unit (fig. 209).

(2) Place flat washer, lock washer, and lock nut on choke control behind switchboard panel (fig. 209).

(3) Work choke control into place, and tighten lock nut (5/8-in. open-end wrench) (fig. 209).

(4) Attach choke control wire to choke lever (screwdriver) (fig. 186).

(5) Tighten screw which secures choke control conduit to clamp on air cleaner (screwdriver) (fig. 186).

(6) Place conduit under clip on nut beneath change-over panel box. Tighten nut (1/2-in. open-end wrench).

(7) Place conduit under clamp on top switchboard panel bracket screw. Tighten screw (screwdriver) (fig. 209).

(8) Install housing (par. 19).

155. GASOLINE STRAINER.

a. Removal (fig. 211).

WRENCH, open-end, 7/16-in. WRENCH, open-end, 1/2-in.

(1) Remove gasoline line from gasoline strainer head (½-in. open-end wrench).

(2) Loosen gasoline strainer bowl thumb screw, and lift gasoline strainer bowl from gasoline strainer head.

(3) Screw gasoline strainer male coupling from carburetor (7/16-in. open-end wrench).

(4) Lift gasoline strainer head from carburetor.

(5) Unscrew filtering element from gasoline strainer head.

b. Inspection and Repair.

COMPRESSED AIR	HAMMER
DOLLY	SOLVENT, dry-cleaning
FILE, 3-cornered (fine)	WIRE

(1) Wash bowl and metal parts in SOLVENT, dry-cleaning. Dry with compressed air.

(2) Inspect bowl. Replace if broken.

(3) Inspect head to see if it is broken, or if orifices are plugged. Clean obstructions from orifices with compressed air or a wire. Replace head if broken.

(4) Examine filtering element to see if any of the three disks which compose it are bent so as to create a gap between them. Replace filtering element if it has any bent disks.

(5) Inspect coupling and elbow to see if either is broken or has damaged threads. Clean burs from threads (fine 3-cornered file). Replace part if broken, or if threads are damaged beyond repair.

(6) Examine bowl gasket. Replace if crushed or torn.

(7) Examine bowl bail and thumb screw. Straighten bail if bent (hammer and dolly). Replace assembly if screw threads are stripped.

c. Installation.

WRENCH, open-end, 7/16-in. WRENCH, open-end, ½-in.

(1) Screw filtering element into gasoline strainer head.

(2) Screw gasoline strainer male coupling, with attached gasoline strainer head, into carburetor (7/16-in. open-end wrench) (fig. 211).

(3) Place gasoline strainer bowl in position and tighten thumb screw.

(4) Connect gasoline line to gasoline strainer head (½-in. open-end wrench).

Section XIX

LUBRICATION: ENGINE LUBRICATION SYSTEM

156. DESCRIPTION.

a. The engine lubrication oil system consists of the oil pan, oil pump, oil pressure gage, oil pressure regulator, oil filter, and necessary connecting parts. It is known as a combination pressure and splash system. Oil drawn by the pump from the oil pan is forced under pressure to a drilled passage on the accessory side of the cylinder block. This drilled passage is plugged on both ends with threaded plugs. Radial holes are drilled from the crankshaft main bearings to this oil gallery which supplies oil to the main bearings. Drilled holes in the crankshaft supply oil under pressure to the connecting rod bearings. The cylinder bores, tappets, and valve stems are lubricated by means of the mist of oil thrown off by the connecting rods and main bearings. The camshaft bearings receive their lubrication from oilholes leading from the valve tappet compartment which is filled by splash. The oil pressure regulator is mounted on the front end of the engine on the accessory drive side. It automatically regulates the oil pressure by means of a piston and spring. The tension of the spring is adjustable, and by this means proper oil pressure can be maintained at all times.

b. The oil filter is mounted on a bracket at the top of the cylinder head, under the canopy engine door. The inlet line is attached to the oil pressure gage line "T". This "T" taps the oil gallery which extends the full length of the cylinder block. The return line is attached to the side of the cylinder block. Unfiltered oil from the crankcase enters the filter through the inlet line, and flows through drilled holes in the inlet line to holes in the center of the oil filter element. The oil is forced through the filter element. The filtered oil is then returned to the crankcase through the outlet line.

c. The oil pump is of the positive spur gear type. It consists of two spur gears enclosed in a 1-piece cast iron housing. It is gear driven from the camshaft. In operation, oil is drawn from the oil pan, through the pump, and to the main oil gallery in the cylinder block.

157. SPECIFICATIONS.

a. Engine.

Make .... Hercules Motor
Type .... Combination pressure and splash
Capacity, crankcase .... 4 qt
Oil pressure .... 15 lb at 1,000 rpm

b. Oil Filter.

Make .... Purolator
Type N-1503
Element .... Replaceable
Element type N-15

158. TROUBLE SHOOTING.

a. Lubrication System Troubles and Remedies.

(1) LOW OIL PRESSURE.

Possible Cause	Possible Remedy
Improper oil level.	Check oil level and fill to proper level.
Improper grade and viscosity of oil.	Drain system and refill with proper grade.
Oil pressure gage defective.	Replace gage (par. 33).
Oil pressure regulating piston stuck open.	Remove oil pressure regulating piston and check action (par. 161).
Oil pan screen clogged.	Remove oil pan and clean screen (par. 116).
Excessive main and connecting rod bearing clearance.	Adjust or replace bearings (par. 129).
Oil pump worn excessively.	Repair oil pump (par. 160).
Oil pump inoperative.	Remove pump and overhaul (par. 160).

(2) HIGH OIL PRESSURE.

Oil pump regulator not properly adjusted.	Adjust oil pump regulating piston (par. 161).
Oil pump regulating piston stuck closed.	Remove oil pressure regulating piston and check action (par. 161).
Oil pressure gage defective.	Replace oil pressure gage (par. 33).

159. OIL FILTER.

a. Removal.

WRENCH, open-end, ½-in. (2)

WRENCH, open-end, $\frac{9}{16}$-in.

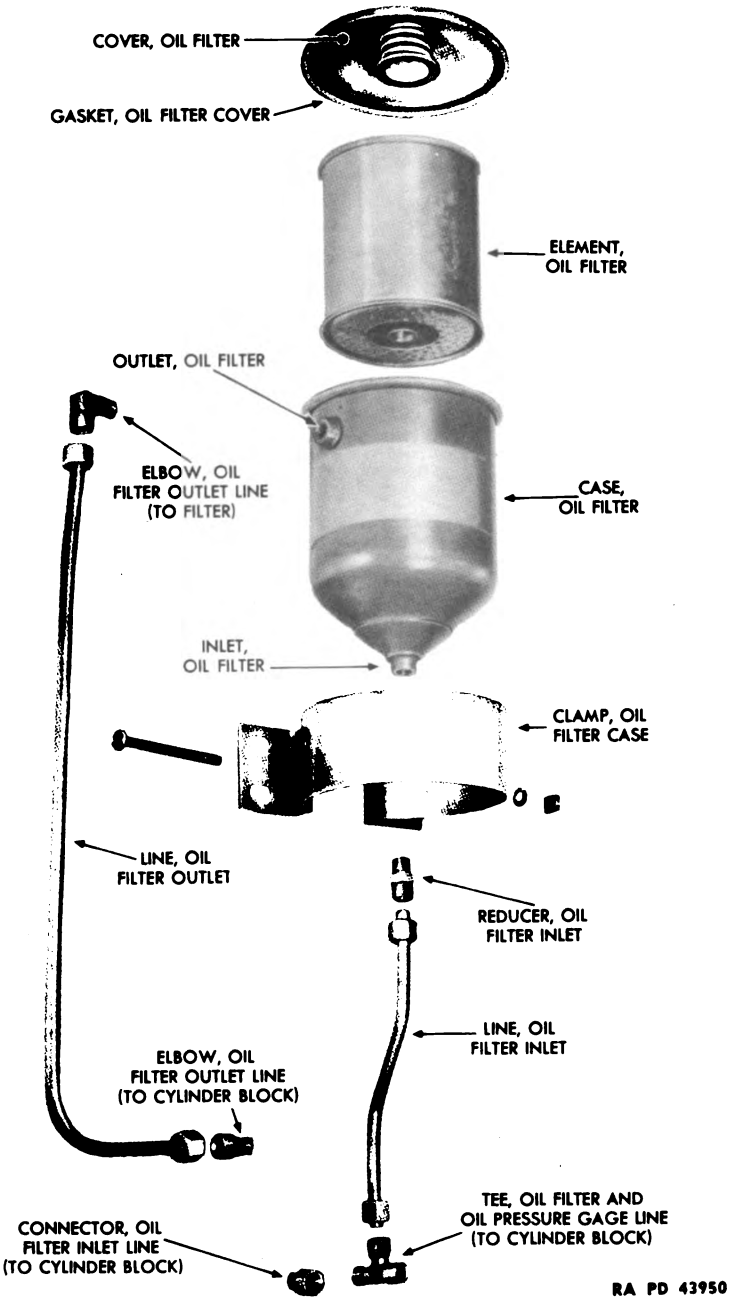

Figure 212 — Oil Filter Assembly — Exploded View

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Make . . . . Hercules Motor
Type . . . . Combination pressure and splash
Capacity, crankcase . . . . 4 qt
Oil pressure . . . . 15 lb at 1,000 rpm

b. Oil Filter.

Make . . . . Purolator
Type N-1503
Element . . . . Replaceable
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Oil pressure gage defective.	Replace gage (par. 33).
Oil pressure regulating piston stuck open.	Remove oil pressure regulating piston and check action (par. 161).
Oil pan screen clogged.	Remove oil pan and clean screen (par. 116).
Excessive main and connecting rod bearing clearance.	Adjust or replace bearings (par. 129).
Oil pump worn excessively.	Repair oil pump (par. 160).
Oil pump inoperative.	Remove pump and overhaul (par. 160).

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Oil pump regulator not properly adjusted.	Adjust oil pump regulating piston (par. 161).
Oil pump regulating piston stuck closed.	Remove oil pressure regulating piston and check action (par. 161).
Oil pressure gage defective.	Replace oil pressure gage (par. 33).

159. OIL FILTER.

a. Removal.

WRENCH, open-end, ½-in. (2) WRENCH, open-end, $\frac{9}{16}$-in.

LUBRICATION: ENGINE LUBRICATION SYSTEM

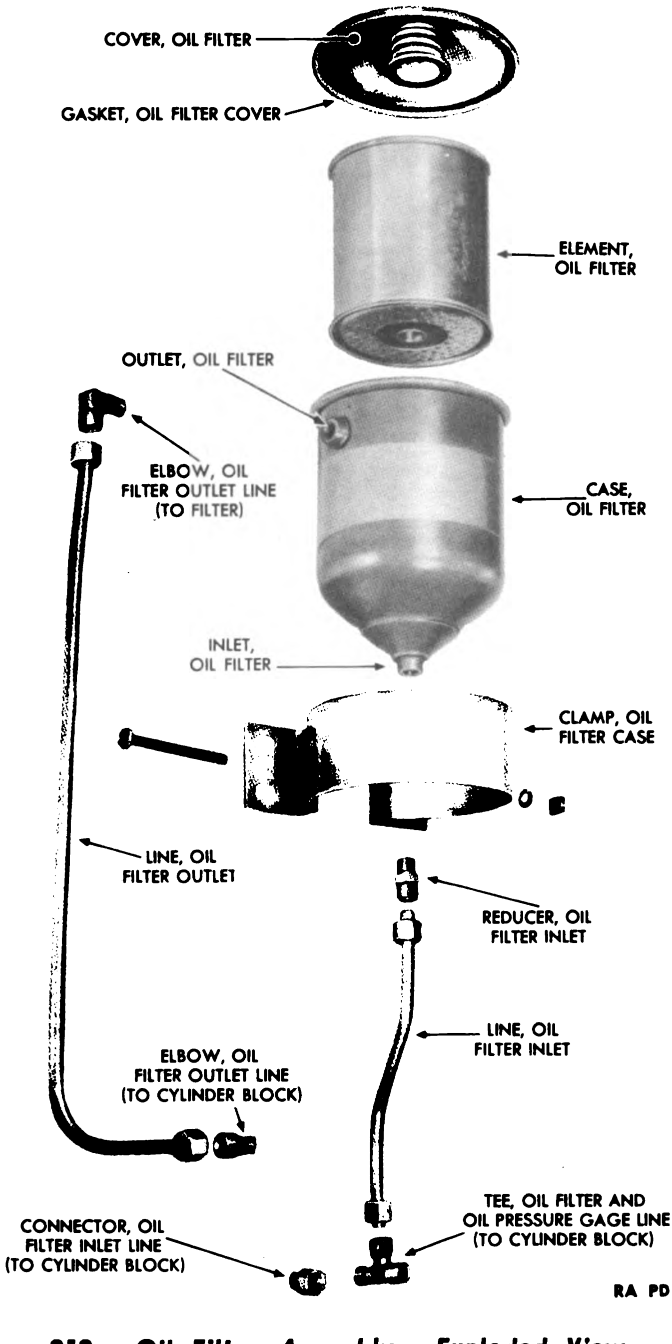


Figure 212 — Oil Filter Assembly — Exploded View

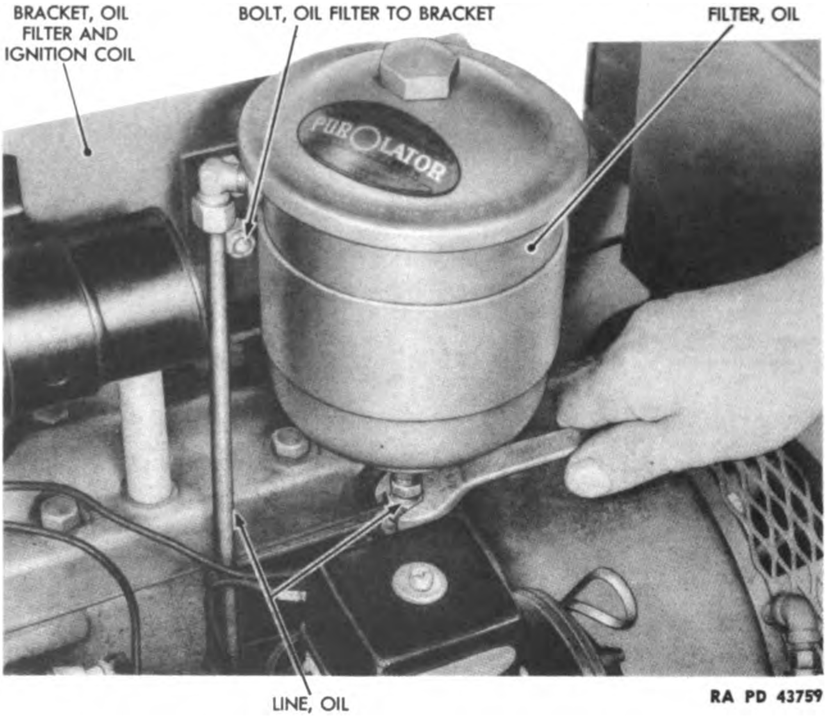


Figure 213 — Removing Oil Filter

(1) Disconnect oil lines at oil filter ($\frac{9}{16}$-in. open-end wrench) (fig. 213).

(2) Remove oil filter to bracket bolts, lock washers, and nuts (two ½-in. open-end wrenches) (fig. 213).

(3) Lift oil filter from bracket (fig. 213).

b. **Disassembly** (fig. 212).

SCREWDRIVER	WRENCH, open-end, $\frac{9}{16}$-in.
WRENCH, open-end, ½-in.	WRENCH, open-end, 1-in.

(1) Remove oil filter inlet line ($\frac{9}{16}$-in. open-end wrench).

(2) Remove oil filter inlet reducer (½-in open-end wrench).

(3) Remove oil filter outlet line ($\frac{9}{16}$-in. open-end wrench).

(4) Remove oil filter outlet line elbow (½-in. open-end wrench).

(5) Remove oil filter cover (1-in. open-end wrench).

(6) Remove oil filter element.

(7) Drain oil from oil filter case.

(8) Remove oil filter case clamp bolt, nut, and lock washers (screwdriver).

(9) Lift oil filter clamp from case.

c. Inspection and Repair.

COMPRESSED AIR SOLVENT, dry-cleaning

(1) Wash all parts thoroughly in SOLVENT, dry-cleaning, and dry with compressed air.

(2) Check to see that oil filter element retainer spring is not broken.

(3) Inspect oil filter inlet line to see that holes are not plugged.

(4) Check oil filter inlet reducer to make sure hole is not plugged.

(5) Check oil filter cover gasket to be sure it is in good condition. Replace if necessary.

d. Servicing Oil Filter.

COMPRESSED AIR WRENCH, open-end, 1-in.
SOLVENT, dry-cleaning

(1) REPLACING OIL FILTER ELEMENT.

WRENCH, open-end, 1-in.

(a) Every 300 hours, or when oil gage rod shows oil is dark, replace oil filter element.

(b) Remove cover (1-in. open-end wrench) and lift oil filter element from case (fig. 212).

(c) Replace oil filter cover gasket, and install new oil filter element.

(d) Assemble cover (1-in. open-end wrench) to oil filter case.

(2) CLEANING OIL FILTER CASE.

COMPRESSED AIR SOLVENT, dry-cleaning

Examine inside of oil filter case, and if there is any trace of foreign matter, remove oil filter from bracket, drain oil, disassemble, thoroughly wash in SOLVENT, dry-cleaning, and dry with compressed air. Reassemble and remount oil filter.

e. Assembly (fig. 212).

SCREWDRIVER WRENCH, open-end, 9/16-in.
WRENCH, open-end, 1/2-in. WRENCH, open-end, 1-in.

(1) Assemble clamp to oil filter case, with opening at opposite side of outlet hole. Attach with bolt, lock washer, and nut (screwdriver).

(2) Assemble a new oil filter element over oil pump case inlet pipe.

(3) Assemble oil filter cover to case (1-in. open-end wrench).

(4) Assemble oil filter inlet reducer (1/2-in. open-end wrench).

(5) Assemble oil filter inlet line to reducer (9/16-in. open-end wrench).

(6) Assemble oil filter outlet line elbow (1/2-in. open-end wrench), and assemble oil filter outlet line to "T" (9/16-in. open-end wrench).

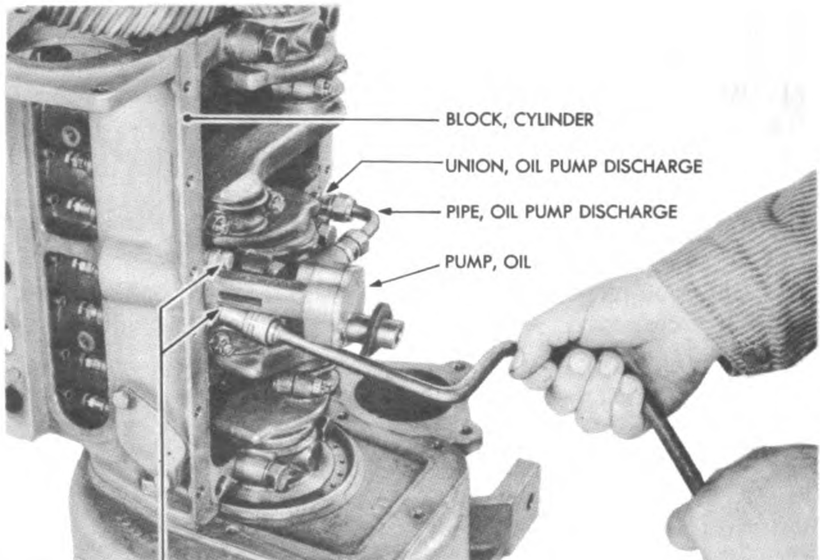


Figure 214 — Removing Oil Pump

f. Installation.

WRENCH, open-end, ½-in. (2) WRENCH, open-end, 9/16-in.

(1) Place oil filter in position on bracket (fig. 213).

(2) Install oil filter to bracket bolts, lock washers, and nuts (two ½-in. open-end wrenches) (fig. 213).

(3) Connect oil lines to oil filter (9/16-in. open-end wrench) (fig. 213).

160. OIL PUMP.

a. Removal.

WRENCH, open-end, ¾-in. WRENCH, socket, ½-in.

(1) Remove engine from unit (par. 114).

(2) Remove oil pan (par. 116).

(3) Disconnect oil pump discharge pipe from oil pump discharge union (¾-in. open-end wrench) (fig. 214).

(4) Remove the oil-pump-to-cylinder-block cap screws and lock washers (½-in. socket wrench) (fig. 214).

(5) Lift oil pump from cylinder block (fig. 214).

LUBRICATION: ENGINE LUBRICATION SYSTEM

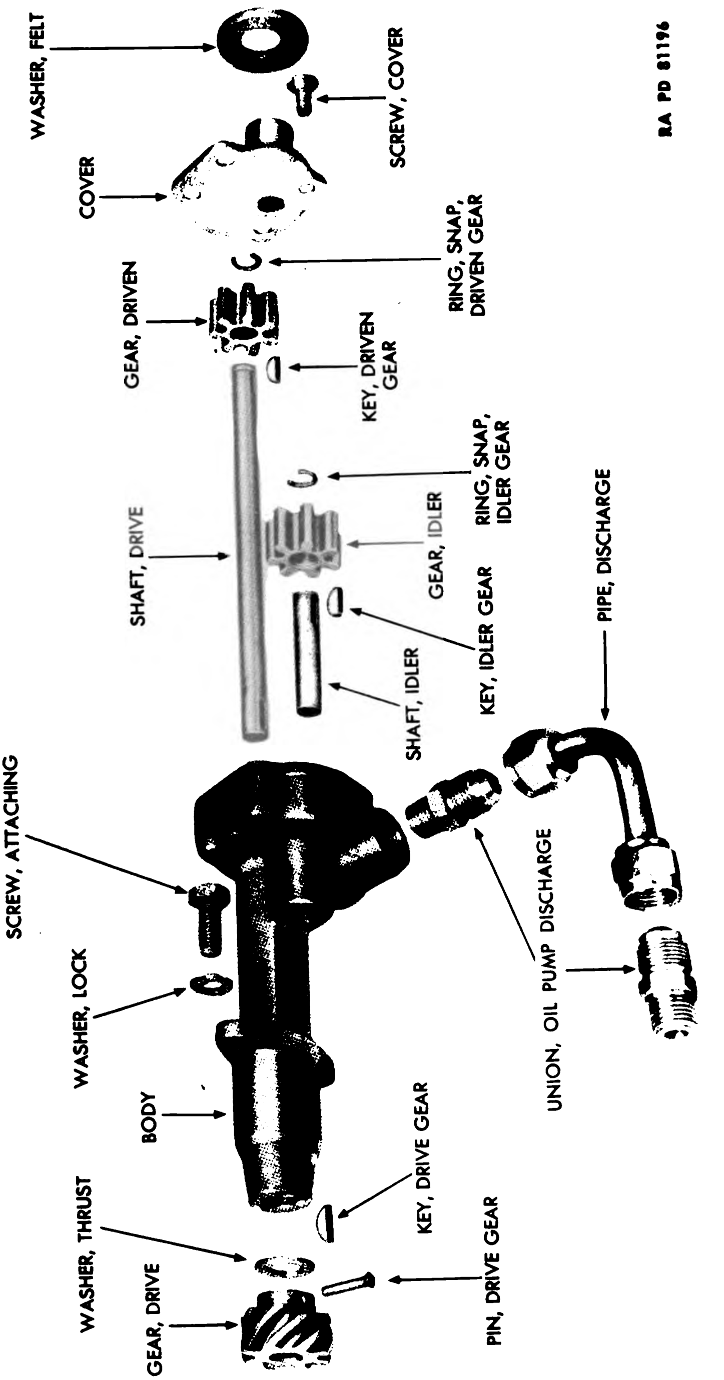


Figure 215—Oil Pump Assembly—Exploded View

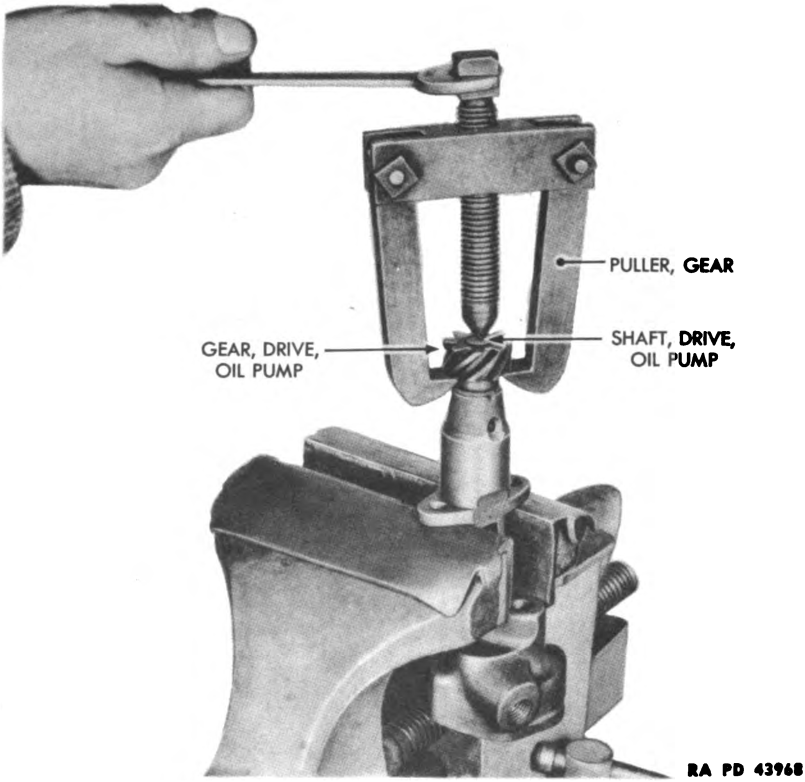


Figure 216 — Removing Oil Pump Drive Gear from Oil Pump Drive Shaft

b. Disassembly (fig. 215).

HAMMER	SCREWDRIVER
PRESS, arbor	WRENCH, open-end, 5/8-in.
PULLER, gear	WRENCH, open-end, 3/4-in.
PUNCH	

(1) Remove oil pump discharge pipe from oil pump discharge union (3/4-in. open-end wrench).

(2) Remove oil pump discharge union from oil pump body (5/8-in. open-end wrench).

(3) Remove four oil pump cover screws (screwdriver), and remove oil pump cover from pump assembly.

(4) Remove oil pump idler shaft and gear assembly from oil pump body (punch and hammer).

(5) Drive oil pump drive gear pin from oil pump drive gear and drive shaft (hammer and punch) (fig. 215).

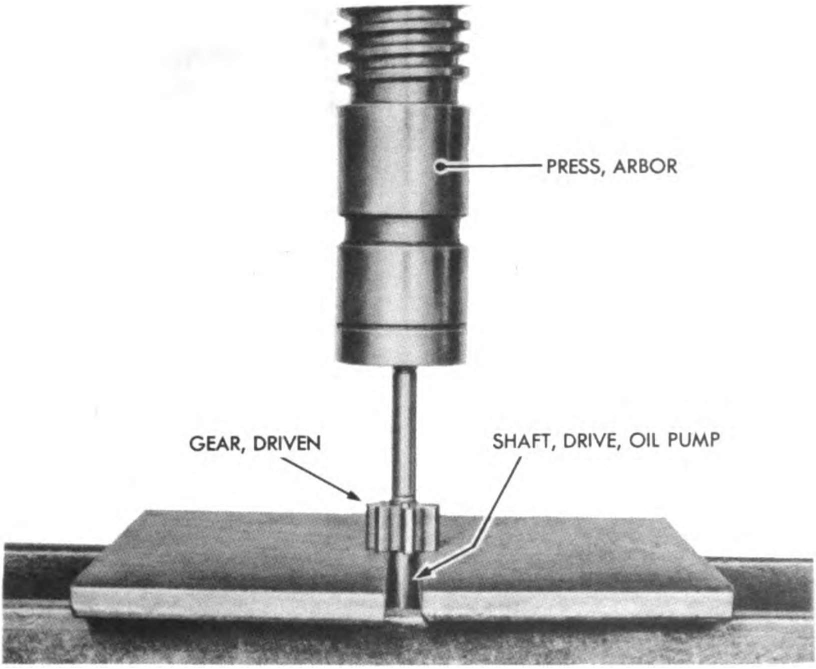


Figure 217 — Pressing Oil Pump Driven Gear on Oil Pump Drive Shaft (First Operation)

(6) Pull oil pump drive gear from drive shaft (gear puller) (fig. 216). CAUTION: Remove oil pump drive gear from shaft. Do not attempt to drive or press oil pump drive shaft from oil pump drive gear, as the oil pump drive gear key will damage washer and oil pump body.

(7) Remove oil pump drive gear washer from shaft.

(8) Remove oil pump drive shaft and driven gear from body (fig. 215).

(9) Press oil pump driven gear from shaft by pressing gear about three-eighth inch up on shaft, and remove snap ring from drive shaft. Press shaft from gear (arbor press) (fig. 218).

(10) Tap oil pump driven gear key from shaft (hammer) (fig. 215).

(11) Press oil pump idler gear from idler shaft (arbor press).

(12) Tap oil pump idler gear key from shaft (hammer) (fig. 215).

c. Inspection and Repair.

(1) Check oil pump drive shaft for wear and damage. Replace if necessary.

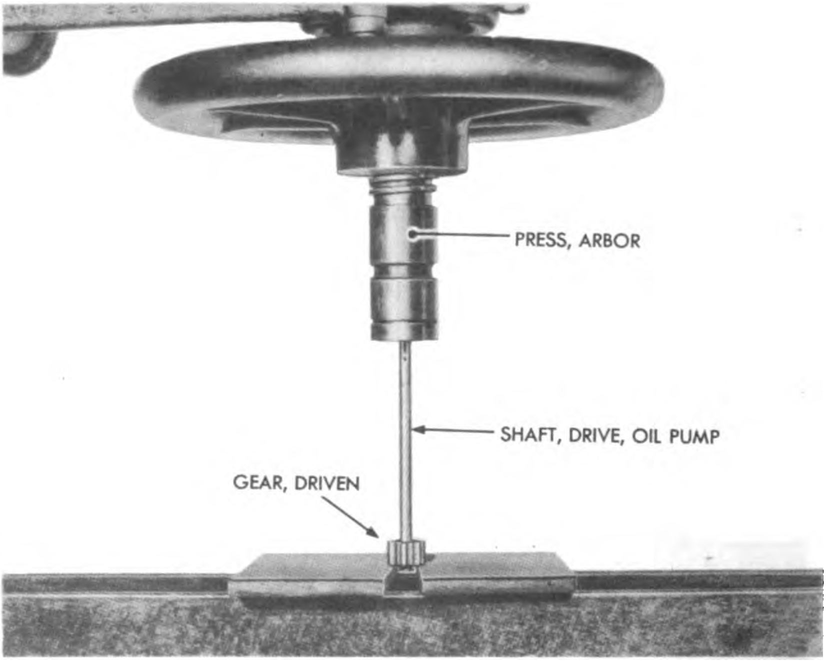


Figure 218 — Pressing Oil Pump Driven Gear on Oil Pump Drive Shaft (Second Operation)

(2) Try fit of oil pump drive shaft in body. It should be a free running fit without side play. Replace oil pump drive shaft or body if worn.

(3) Inspect condition of all oil pump gears. Replace damaged gears.

(4) Inspect condition of oil pump gear keys. Replace damaged keys.

d. Assembly.

HAMMER	SCREWDRIVER
PRESS, arbor	WRENCH, open-end, ⅝-in.
PUNCH	WRENCH, open-end, ¾-in.

(1) Press oil pump drive shaft into oil pump driven gear so end of shaft extends down past gear about three-eighths inch (arbor press) (fig. 217).

(2) Assemble oil pump snap ring to shaft. Place oil pump key in position in shaft, and press shaft down into gear until snap ring is flush with recess in gear (arbor press) (fig. 218).

(3) Assemble oil pump idler gear to idler gear shaft (arbor press).

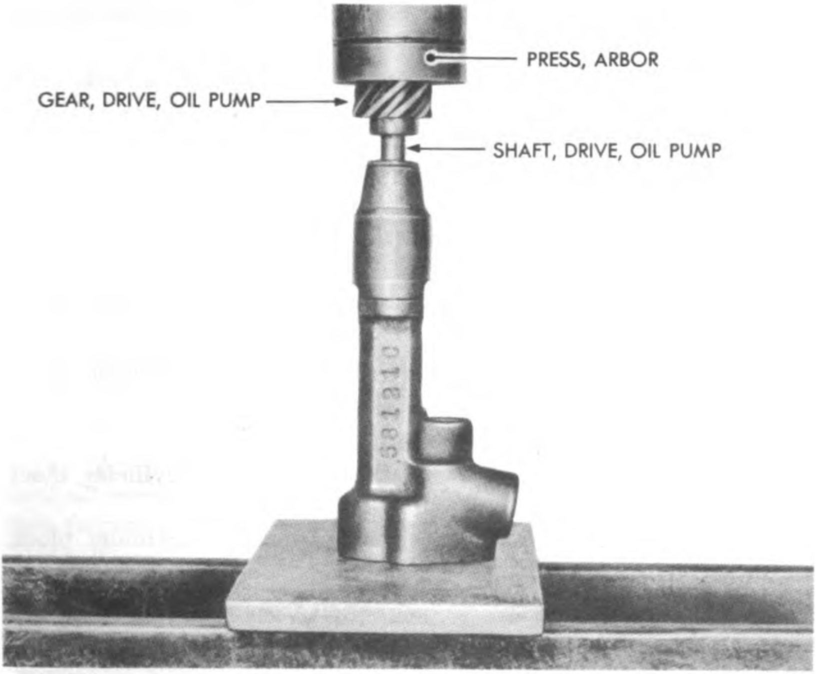


Figure 219 — Pressing Oil Pump Drive Gear on Oil Pump Drive Shaft

(4) Insert oil pump drive shaft and driven gear assembly in oil pump body.

(5) Assemble oil pump drive gear washer over shaft, and place oil pump gear key in position in shaft (fig. 215).

(6) Press oil pump drive gear on shaft, making sure gear pin holes line up with hole in shaft (arbor press) (fig. 219).

(7) Drive new pin in oil pump drive gear and shaft (hammer).

(8) Assemble oil pump idler gear and shaft assembly to oil pump body.

(9) Place oil pump cover in position and assemble four oil pump cover screws (screwdriver) and stake in place (punch and hammer).

(10) Assemble oil pump union (⅝-in. open-end wrench), and assemble oil pump discharge pipe (¾-in. open-end wrench) to oil pump union.

e. **Installation** (fig. 214).

WRENCH, open-end, ¾-in. **WRENCH**, socket, ½-in.

(1) Place oil pump in position in cylinder block.

(2) Install oil pump to cylinder block cap screws and lock washers (½-in. socket wrench).

(3) Connect oil pump discharge pipe to oil pump discharge pipe union in cylinder block (¾-in. open-end wrench).

(4) Install oil pan (par. 129).

(5) Install engine in unit (par. 131).

161. OIL PRESSURE REGULATOR.

a. Removal (fig. 220).

SCREWDRIVER — WRENCH, open-end, 1¼-in.
WRENCH, open-end, 1-in.

(1) Remove regulator acorn nut from adjusting screw (1-in. open-end wrench).

(2) Lift acorn nut gasket from adjusting screw.

(3) Remove adjusting screw and lock nut from cylinder block (1¼-in. open-end wrench and screwdriver).

(4) Lift lock nut gasket, spring, and piston from cylinder block.

b. Inspection and Repair.

COMPRESSED AIR — SOLVENT, dry-cleaning

(1) Clean all metal parts with SOLVENT, dry-cleaning, and dry with compressed air.

(2) Inspect metal parts to see if any are broken, worn, scored, or have damaged threads. Replace all damaged parts. Replace gasket every time oil pressure regulator is disassembled.

c. Assembly (fig. 220).

SCREWDRIVER — WRENCH, open-end, 1¼-in.
WRENCH, open-end, 1-in.

(1) Assemble piston and spring to cylinder block.

(2) Assemble lock nut and lock nut gasket to adjusting screw.

(3) Install adjusting screw and lock nut in cylinder block.

(4) Start engine and turn adjusting screw to right or left until oil pressure gage on switchboard panel shows 15 pounds pressure (fig. 221) (screwdriver).

(5) Tighten lock nut (1¼-in. open-end wrench).

(6) Assemble acorn nut gasket and acorn nut to adjusting screw (1-in. open-end wrench) (fig. 220).

d. Adjustment.

SCREWDRIVER — WRENCH, open-end, 1¼-in.
WRENCH, open-end, 1-in.

(1) Remove acorn nut from adjusting screw (1-in. open-end wrench) (fig. 220).

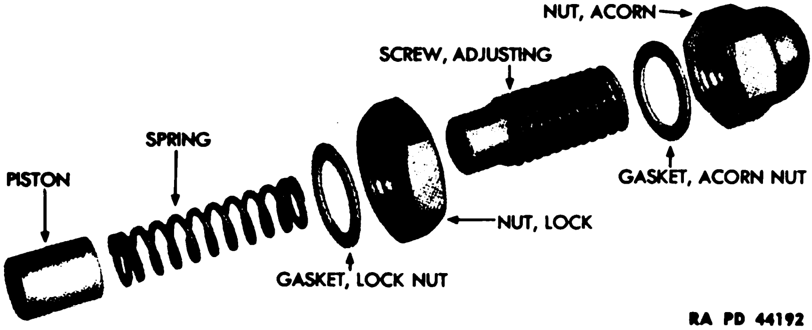


Figure 220 — Oil Pressure Regulator — Exploded View

(2) Remove acorn nut gasket from adjusting screw (fig. 220).

(3) Loosen adjusting screw lock nut (1¼-in. open-end wrench and screwdriver) (fig. 220).

(4) With engine running, turn adjusting screw to right or left until oil pressure gage on switchboard panel shows 15 pounds pressure (screwdriver) (fig. 221).

(5) Tighten lock nut (1¼-in. open-end wrench).

(6) Install acorn nut gasket and nut (1-in. open-end wrench) (fig. 220).

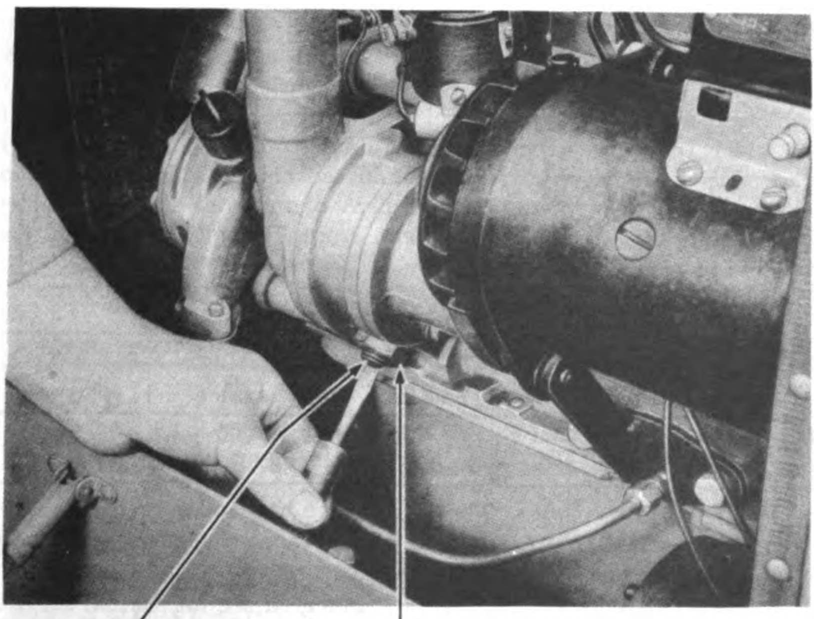


Figure 221 — Adjusting Oil Pressure Regulator

Section XX

LUBRICATION INSTRUCTIONS FOR GENERATING UNITS M5 AND M6

Paragraph

162. GENERAL.

a. The following lubrication instructions for generating Units M5 and M6 are published for the information and guidance of all concerned, and supersede all previous instructions.

(1) REFERENCES. Materiel must be lubricated in accordance with the latest instructions contained in Technical Manuals and/or Ordnance Field Service Bulletins. Reference is made to OFSB 6-4, Artillery Lubrication, General, for additional lubrication information, and to OFSB 6-2, Product Guide, for latest approved lubricants.

163. LUBRICATION GUIDE.

a. Lubrication instructions for all points to be serviced by using arms are shown in War Department Lubrication Guide No. 120, which specifies the types of lubricants required and the intervals at which they are to be applied. Guides from which information is reproduced are 10- by 15-inch laminated charts which are part of the accessory equipment of each piece of materiel. Data contained in the lubrication guides are taken from Technical Manuals, and are binding on using troops.

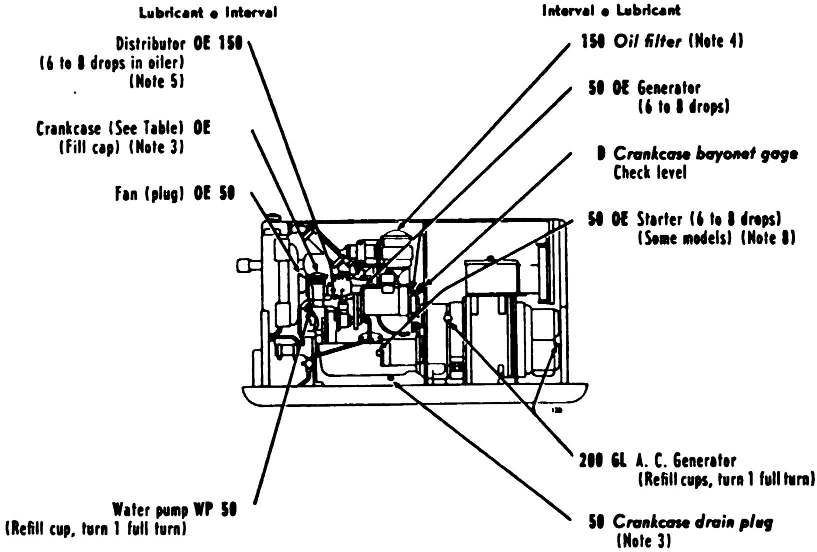
TABLE OF CAPACITIES AND LUBRICANTS TO BE USED

UNIT	CAPACITY (Approx.)	LOWEST EXPECTED AIR TEMPERATURE		
		+32 F and above	+32 F to zero F	Below zero F
Crankcase	4 qt	OE SAE 30	OE SAE 10	Refer to OFSB 6-5

b. Lubrication Notes. The following notes apply to the lubrication guide (fig. 222). All note references in the guide itself are to the subparagraphs below having the corresponding numbers:

(1) INTERVALS. The intervals indicated are for normal service. For extreme conditions of heat, water, sand, dust, etc., reduce interval by a third or a half, or more if conditions warrant.

LUBRICATION INSTRUCTIONS FOR GENERATING UNITS M5 AND M6



KEY

LUBRICANTS	
OE—OIL, engine Crankcase grade	WP—GREASE, water pump
CG — GREASE, general purpose No. 1 (above +32° F.) No. 0 (below + 32° F.)	GL—GREASE, lubricating, special

INTERVALS
D—DAILY
50— 50 HOURS
150—150 HOURS
200—200 HOURS
CHECK DAILY
Crankcase
Air cleaner

RA PD 81199

Figure 222 — Lubrication Guide — Generating Units M5 and M6

(2) AIR CLEANER. The air cleaner is located on the right side of the engine. Daily, check level and refill oil reservoir to bead level with used crankcase oil or OIL, engine (crankcase grade). Every 100 hours, or daily when operating in extreme dust conditions, remove air cleaner and wash all parts. Proper maintenance of air cleaners is essential to prolonged engine life.

(3) CRANKCASE. Drain only when engine is hot. Every 50 hours, drain and refill to "FULL" mark on gage. Run engine a few minutes and recheck oil level. CAUTION: Be sure pressure gage indicates that oil is circulating.

(4) OIL FILTER. Every 150 hours, or more often if filter becomes clogged, renew filter element. After renewing element, refill crankcase to "FULL" mark on gage. Run engine a few minutes, recheck level, and add oil to "FULL" mark.

(5) DISTRIBUTOR. Every 50 hours wipe distributor breaker cam lightly with GREASE, general purpose (seasonal grade), and apply 1 or 2 drops of OIL, engine (crankcase grade), to wick under rotor. Lubricate breaker arm pivot with 1 or 2 drops of OIL, engine (crankcase grade). Every 150 hours apply 6 to 8 drops of OIL, engine (crankcase grade) to distributor shaft oiler.

(6) FUEL STRAINER. The fuel strainer is located on the right side of the engine. Check fuel strainer bowl daily. When necessary, remove and wash bowl.

(7) OILCAN POINTS. Every 50 hours lubricate throttle connections and governor linkage with OIL, engine (crankcase grade).

(8) COLD WEATHER. For lubrication and service below zero F, refer to OFSB 6-5.

164. POINTS TO BE SERVICED AND/OR LUBRICATED BY ORDNANCE MAINTENANCE PERSONNEL.

a. Starter (some models). Once each year disassemble, clean, and repack armature bearings with GREASE, general purpose No. 2. Wash over-running clutch and pinion in SOLVENT, dry-cleaning, coat lightly with OIL, engine (crankcase grade), and reassemble.

165. REPORTS AND RECORDS.

a. Reports. If lubrication instructions are closely followed, proper lubricants used, and satisfactory results are not obtained, a report will be made to the ordnance officer responsible for the maintenance of the materiel.

b. Records. A complete record of lubrication servicing will be kept.

Section XXI

CONSOLIDATED SERVICE DATA

166. FITS AND CLEARANCES.

a. Clearance Between:

	Minimum	Maximum
Valve tappet and valve stem, intake (hot)	0.006 in.	
Valve tappet and valve stem, intake (cold)	0.008 in.	
Valve stem and valve guide, intake	0.001 in.	0.0015 in.
Valve stem and valve guide, exhaust	0.001 in.	0.0015 in.
Valve tappet and valve tappet guide	0.00075 in.	0.001 in.
Idler bearing and idler gear shaft	0.001 in.	0.0015 in.
Camshaft bearing and camshaft	0.0015 in.	0.0025 in.
Cylinder main bearing and crankshaft	0.002 in.	0.0025 in.
Bell housing and chamfer on crankshaft	0.012 in.	0.025 in.
Connecting rod bearing and crankshaft	0.001 in.	0.0015 in.
Connecting rod bearing and crankshaft (end play)	0.005 in.	0.010 in.
Accessory drive bearing and accessory drive shaft	0.0015 in.	0.002 in.
Accessory drive bearing and accessory drive thrust washer (end play)	0.001 in.	0.002 in.
Gear cover and crankshaft	0.008 in.	0.015 in.
Oil pan and crankshaft	0.008 in.	0.015 in.
Piston and cylinder wall	0.002 in.	0.0025 in.
Piston ring and groove in piston	0.001 in.	0.0025 in.
Piston pin and piston	0.0005 in.	

b. Gear Backlash:

Accessory drive gear	0.002 in.	0.003 in.
Crankshaft gear	0.000 in.	0.002 in.
Idler gear	0.001 in.	0.002 in.
Oil pump gear	0.008 in.	0.010 in.

c. Gap Settings:

Piston ring end gap	0.015 in.	0.020 in.
Spark plug electrodes	0.025 in.	
Distributor breaker points	0.018 in.	

d. End Thrust:

Crankshaft	0.002 in.	0.004 in.
Connecting rod bearing	0.005 in.	0.010 in.
Accessory drive bearing	0.001 in.	0.002 in.

	Minimum	Maximum
e. Dimensions:		
Main generator driving flange stud top to face of flywheel		$2\frac{1}{64}$ in.
Valve guide top to machined face of cylinder block		$1\frac{9}{32}$ in.
Undercut mica, exciter commutator		
Width		0.030 in.
Depth	0.020 in.	0.025 in.
f. Spring Tensions:		
Main generator commutator brush arm		12 oz
Main generator slip ring brush arm		8 oz

167. WRENCH TENSIONS.

	Inch-pounds	Foot-pounds
Cylinder head	504	42
Connecting rod	276	23
Cylinder main bearing	924	77

Section XXII

PREPARATION FOR USE IN COLD CLIMATE

168. GENERAL.

a. Operation and maintenance of the unit at low temperatures involve factors not found at normal operating temperatures, and operators must devote more time to protective maintenance. Failure to provide extra service will result in actual damage, unnecessary and unwarranted expense, and failure to start.

b. Low temperatures have been divided into two ranges: zero F to —20 F, and below —20 F. Engines and lubricants undergo changes in their physical properties below —20 F. In many cases, accessory equipment for supplying heat to engine, fuel, oil, and intake air is required.

169. GASOLINE FOR LOW TEMPERATURES.

a. Selection. Use the winter class of motor fuel procured under U. S. Army Specification 2-103, latest issue.

b. The formation of ice crystals from small quantities of water in the fuel sometimes causes considerable trouble. To keep water out of the fuel tank, observe the following precautions:

(1) Strain the gasoline through a suitable strainer. CAUTION: Be sure to provide a positive metallic contact between fuel container and gasoline tank, unless both fuel tank and container are independently grounded.

(2) Insofar as possible, always keep the fuel tanks full. This will reduce condensation of water from the free air space above the fuel.

(3) Add one-eighth pint of ALCOHOL, denatured, to a tank of gasoline. The alcohol will absorb the water and prevent it from freezing.

(4) Do not store fuel in old drums unless they have been thoroughly cleaned.

(5) Never pump fuel drums dry when filling vehicle fuel tanks; allow about 4 inches of fuel to remain. This residue can later be

transferred to a settling tank. If time is not an urgent factor, do not pump fuel from drum to unit until it has settled for 16 hours after filling or moving the drum. Keep portable fuel pumps clean and protected from snow and frost.

(6) When a drum has been opened, be sure to cover the opening or replace the bung to keep out snow, frost, or other foreign matter. Store drums in a covered building, or cover with a tarpaulin.

170. ENGINE LUBRICATION.

a. Engine lubrication at temperatures above zero F is covered in the Lubrication Guide. The following instructions supplement this information, and apply only to instances where the temperature falls below zero F for long periods.

b. Several methods of keeping engine oil sufficiently fluid for proper lubrication at temperatures below —10 F are listed below. Give preference to these methods in the order listed according to available facilities.

(1) Keep the unit in heated enclosure when not in operation.

(2) When engine is stopped, drain crankcase oil while it is hot, and store in a warm place until unit is to be operated again. If warm storage is not available, heat the oil before reinstalling. Avoid overheating the oil; heat only to the point where the bare hand can be inserted without burning. *Tag the unit in a conspicuous place to warn personnel that crankcase is empty.* Close shut-off valves to prevent flooding of the carburetor and crankcase dilution, because of the accumulation of gasoline vapor pressure in the gasoline tanks.

(3) If unit is to be kept outdoors and if the oil cannot be drained, cover the engine with a tarpaulin. About 3 hours before engine is to be started, place fire pots under the tarpaulin. Use the Van Prag, Primus type, or other type blowtorch, or ordinary kerosene lanterns.

(4) Dilute the crankcase oil with gasoline. For satisfactory starting in temperatures below zero F, use four-fifths quart of gasoline to each 4 quarts of the engine oil prescribed on the Lubrication Guide for use at zero F.

171. COOLING SYSTEM PROTECTION.

a. Antifreeze Solutions.

(1) In freezing weather, protect the cooling system by addition of an antifreeze solution, employing COMPOUND, antifreeze (ETHYLENE GLYCOL type).

(2) The following table gives the approximate quantity of antifreeze necessary for various temperature conditions; check, however, with an antifreeze solution hydrometer.

PREPARATION FOR USE IN COLD CLIMATE

ANTIFREEZE CHART

Antifreeze	Water	Compound Antifreeze	
Qt	Qt	Degrees F	Gravity
0	5	32	1.000
½	4½	26	1.016
1	4	16	1.031
1½	3½	3	1.045
2	3	—11	1.058
2½	2½	—31	1.070

b. Precautions.

(1) Do not mix antifreeze solutions.

(2) Before installing antifreeze solution:

(a) Thoroughly flush the cooling system.

(b) Check system for leaks; tighten hose connections and replace if necessary; and check thermostat and water pump. Make sure that the pump is properly lubricated.

(c) Check fan belt for adjustment or weakness. Do not use rubber fan belts at temperatures below —20 F. Use leather, fiber, or synthetic rubber fan belts.

172. ELECTRICAL SYSTEM PROTECTION.

a. Generator and Starter. Inspect brushes, commutators, and bearings. See that the commutators are clean. Large surges of current which occur when starting a cold motor require good contact between brushes and commutators.

b. Wiring. Inspect and clean all connections, especially the battery terminals. Take care that no short circuits are present and that there is no ice on the spark plugs, wiring, or other electrical equipment.

c. Coil. Check coil for proper functioning.

d. Distributor. Clean thoroughly, and clean or replace points. Check the points frequently. In cold weather when the current is heavier, the points may pit and burn more than usually.

e. Spark Plugs. Clean, test, and replace if necessary. If it is difficult to make engine fire, reduce gap 0.005 inch more than specified for normal operation. This will make sparking easier at the reduced voltages likely to prevail.

f. Timing. Check carefully. Take care that the spark is not unduly advanced or retarded.

g. Batteries.

(1) The efficiency of batteries decreases sharply with decreasing temperatures and becomes practically nil at —40 F. Do not attempt

to start the engine with the battery when it has been exposed to temperatures below —30 F, until the battery has been warmed.

(2) A fully charged battery will not freeze even at temperatures likely to be found in arctic climates, while a fully discharged battery will freeze and rupture at approximately 18 F. See that the battery is always fully charged with hydrometer reading between 1.275 and 1.300. If a hydrometer is not available, use ammeter and voltmeter to determine battery condition.

(a) Due to the action of the generator regulator, the ammeter reading at constant engine speed will be low when the battery is fully charged, and high when the battery is weak or discharged. To obtain an indication of battery condition, frequently check ammeter readings at approximately equal engine speeds.

(b) Voltmeter readings, taken at intervals, with the same load on the battery, will provide a clue to potential battery performance.

(3) Maintain electrolyte level three-eighths inch above top of plates. If necessary to add distilled water, wait until the engine and battery have warmed up. Keep ventholes in filler plugs open. Keep terminals tight and clean. At regular intervals, apply a coating of GREASE, general purpose, No. 0, or COMPOUND, rust-preventive, light.

173. GENERAL CONDITIONS.

a. Make sure that no heavy grease or dirt has been left on the starter throw-out mechanism. Heavy grease or dirt may keep the gears from being meshed, or cause them to remain in mesh after the engine starts and thus ruin the starter.

b. Pull the choke control all the way out to secure the air-fuel ratio required for cold weather starting. Make sure the butterfly valve in the carburetor closes all the way and otherwise functions properly.

c. Carburetors which give no appreciable trouble at normal temperatures may not operate satisfactorily at low temperatures. A fuel pump which will deliver enough gasoline at normal starting speeds of 400 revolutions per minute may have leaky valves or a diaphragm which will prevent it from delivering a sufficient quantity of fuel at cranking speeds of 30 to 60 revolutions per minute. Another source of trouble is the float needle valve which, although a close fit, must move freely. Different expansions of the metals used in the needle valve parts may cause the needle valve to stick at extremely low temperatures.

d. At temperatures below zero F, do not use oil in air cleaners. The oil will congeal and prevent easy flow of air. At temperatures below —30 F, remove the air cleaners. Ice and frost formations on

the air cleaner screens may cause an abnormally high intake vacuum and an overrich mixture.

e. Inspect the unit frequently. Shock resistance of metals, or resistance against breaking, is greatly reduced at extremely low temperatures. Movement of units on hard, frozen ground causes strain and jolting which will loosen or break bolts and nuts.

f. Remove or bypass oil filters at temperatures below —30 F, because the viscous oil will not flow freely through them.

g. Remove and clean gasoline strainer at frequent intervals.

174. STARTING AND OPERATION.

a. Temperatures from Zero F to —30 F.

(1) It is possible to start gasoline engines with batteries at temperatures as low as —30 F, if the engines are properly lubricated and in good mechanical condition.

(2) To ensure that the engine will start on the first attempt, proper preparation of the engine is very important. Should the engine fire a few times and stop, water vapor which is a product of combustion, may form frost in the combustion chamber, and make it impossible to start without heating the engine to above 32 F. Prolonged starting efforts wear down the battery.

(3) Pull the choke lever all the way out for starting, and keep it partially pulled out until the engine has warmed up. Since only the lightest components of the gasoline vaporize in a cold engine, a very rich mixture is necessary.

(4) When attempting to start, turn the engine over as rapidly as possible. All engines have a critical cranking speed; i.e., the engine must be turned over at a certain rate of speed before any start at all is possible. For engines in good mechanical condition, this critical rate of speed may vary from 40 to 70 revolutions per minute.

(5) After the engine has been started, idle it at 800 to 1,000 revolutions per minute until it has warmed up enough to run smoothly. Do not place the unit in operation until its operating temperature of 160 F has been reached.

b. Temperatures Below —30 F.

(1) Cover engine with tarpaulin, tent, or portable shed. Place oil stoves, fire pots, or four or five ordinary kerosene lanterns under the covering about 3 hours prior to starting time.

(2) Keep unit in sheltered areas shielded from wind. Cold winds increase starting difficulties.

175. COLD WEATHER ACCESSORIES.

a. A number of the most commonly used accessories have been mentioned in the preceding sections. These, together with other

accessories and attachments used successfully in northern climates, are listed below. The use of these accessories is not mandatory. They are given only as suggestions and are to be used at the discretion of officers in charge of the materiel.

(1) Tarpaulins, tents, or collapsible sheds are useful for covering units, particularly for the engines.

(2) Fire pots (Primus type) or Van Prag blowtorches, ordinary blowtorches, oil stoves, or kerosene lanterns can be used for heating unit.

(3) Extra batteries and facilities for changing batteries quickly help in starting.

(4) Steel drums and suitable metal stands are useful in heating crankcase oil.

(5) Insulation for the fuel line helps prevent ice formation inside the line.

(6) Radiator covers, improvised locally, help keep the engine running at normal temperatures.

Section XXIII

SPECIAL TOOLS AND EQUIPMENT

176. TOOLS FURNISHED WITH UNIT.

a. Each Unit M5 and each Unit M6 is equipped with a set of tools which is housed in the tool box. Included are a trouble light, screwdriver, pliers, spark plug wrench, valve lifter, adjustable wrench, a set of six open-end wrenches, and a cloth case for the open-end wrenches (fig. 223). A gasoline funnel and crank are attached to the inside of the canopy (fig. 223). The funnel and crank are reached by opening the right-hand engine door.

177. SPARE PARTS FURNISHED WITH UNIT.

a. Bolted to the under side of the right-hand engine door of the housing are four extra cylinder head gaskets (fig. 224). Within the tool box are two manifold gaskets, two lengths of radiator hose, four hose clamps, a fan belt, a battery charging generator drive belt (fig. 224), four valve springs, two intake valves, four exhaust valves, four main generator commutator brushes, four main generator slip ring brushes, eight valve spring seat pins, two gasoline strainer pads, three 25-ampere main generator fuses, two sets of distributor breaker points, four spark plugs, two cotter pins, and an assortment of screws, nuts, and washers (fig. 225). With the Unit M6, an extra fixed resistor and an extra variable resistor are also furnished (fig. 225).

178. SPECIAL TOOLS.

a. **General.** Simplicity of design of the generating unit makes it possible to do nearly all repair operations with standard automotive equipment. Only three special tools are required: a pilot for removing the accessory drive bushing from the accessory drive housing (fig. 226), and two bearing drivers for installing bearings in the governor (figs. 227 and 228).

b. **Accessory Drive Bushing Pilot.** In use, the disk with the flattened side is inserted through the large opening of the housing, through the bushing. The disk is then maneuvered so that it lies flat on top of the bushing. The rod is then inserted through the small opening on top of the housing. With the rod against the disk, the bushing is driven out by hammering the end of the rod projecting from the housing. This tool is easily constructed from stock steel or scrap parts. Build it to the dimensions shown (fig. 226).

c. **Governor Bearing Drivers.** Construct two bearing driving tools to dimensions shown in illustrations (figs. 227 and 228) from stock steel.

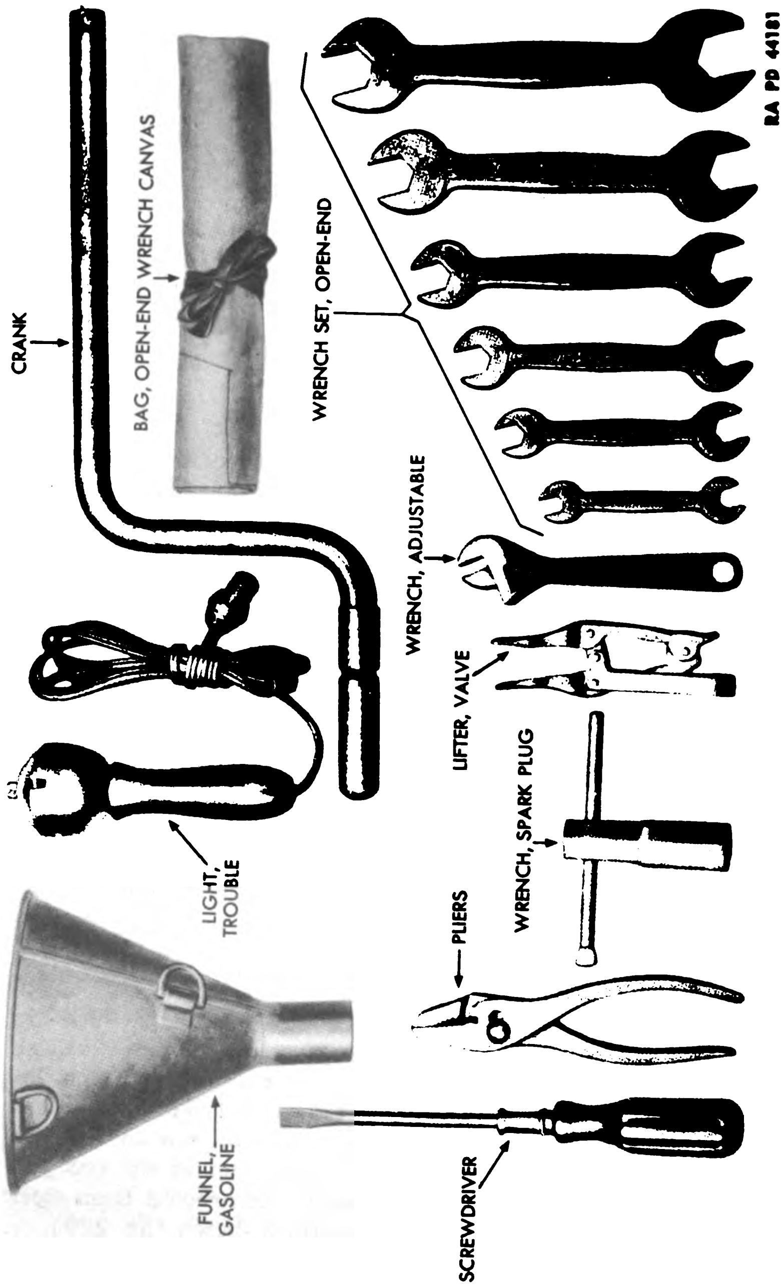


Figure 223 — Tools

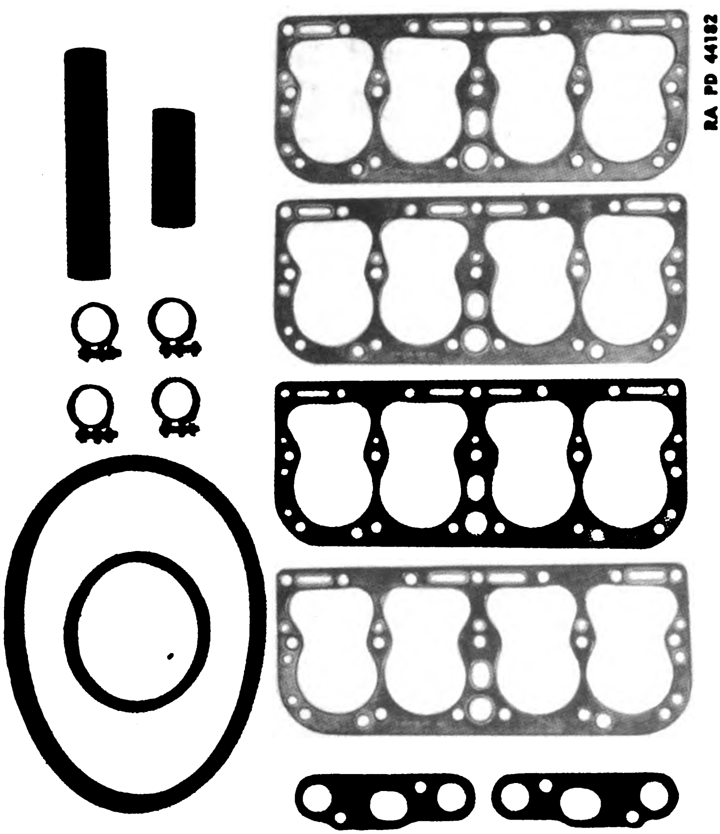


Figure 224 — Equipment — Gaskets, Hose, and Belts

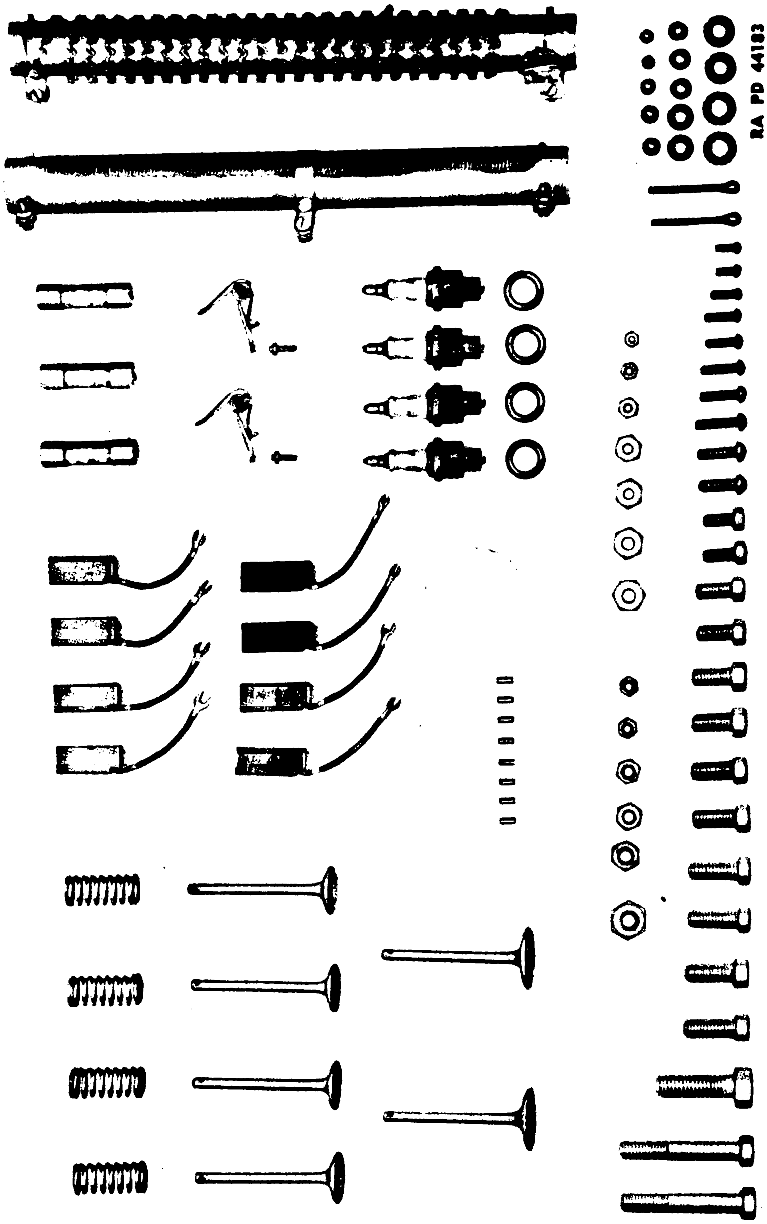


Figure 225 — Equipment — Small Parts

SPECIAL TOOLS AND EQUIPMENT

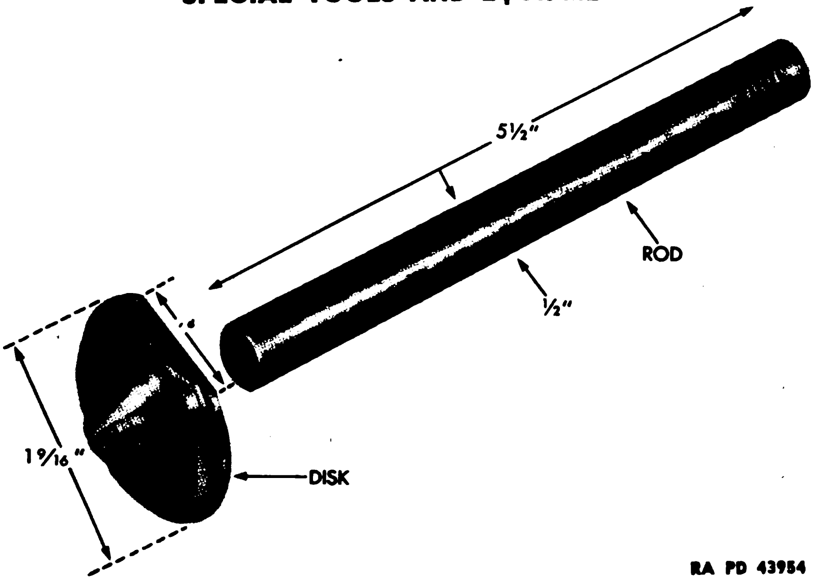


Figure 226 — Pilot for Removing Accessory Drive Bushing from Accessory Drive Housing

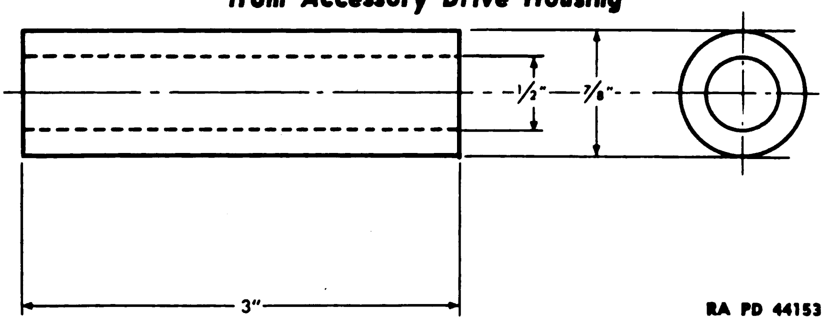


Figure 227 — Governor Bearing Driver — Large

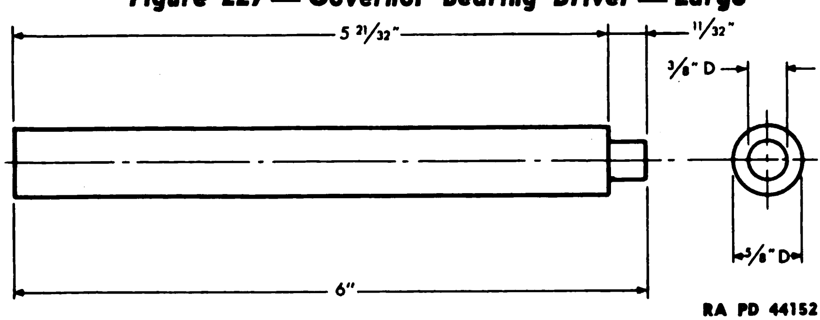


Figure 228 — Governor Bearing Driver — Small

Section XXIV

PAINTING

179. GENERAL.

a. Ordnance materiel is painted before issue to the using arms, and one maintenance coat per year will ordinarily be ample for protection. With but few exceptions, this materiel will be painted with ENAMEL, synthetic, olive-drab, lusterless. The enamel may be applied over old coats of oil enamel and oil paint previously issued by the Ordnance Department, if the old coat is in satisfactory condition for repainting.

b. Paints and enamels are usually issued ready for use and are applied by brush or spray. They may be brushed on satisfactorily when used unthinned in the original package consistency, or when thinned no more than 5 percent by volume with THINNER, synthetic. The enamel will spray satisfactorily when thinned with 15 percent by volume of thinner. (Linseed oil must not be used as a thinner since it will impart a lustre not desired in this enamel.) If sprayed, it dries hard enough for repainting within one-half hour, and dries hard in 16 hours.

c. Certain exceptions to the regulations concerning painting exist. Fire-control instruments, sighting equipment, and other items which require a crystalline finish will not be painted with ENAMEL, synthetic, olive-drab, lusterless.

d. In no case should an oil or kerosene mixture be used to impart a polished surface.

180. PREPARING FOR PAINTING.

a. If the base coat on the materiel is in poor condition, it is more desirable to strip the old paint from the surface than to use sanding and touch-up methods. After stripping, it will then be necessary to apply a primer coat.

b. PRIMER, synthetic, refinishing, should be used on wood as a base coat for synthetic enamel. It may be applied either by brushing or spraying. It will brush satisfactorily as received, or after the addi-

tion of not more than 5 percent by volume of thinner. It will be dry to touch in 30 minutes, and hard in from 5 to 7 hours. For spraying, it may be thinned with not more than 15 percent by volume of thinner. Lacquers must not be applied to the primer within less than 48 hours.

c. PRIMER, synthetic, rust-inhibiting, for bare metal, should be used on metal as a base coat. Its use and application is similar to that outlined in subparagraph b above.

d. The success of a job of painting depends partly on the selection of a suitable paint, but also largely upon the care used in preparing the surface prior to painting. All parts to be painted should be free from rust, dirt, grease, kerosene, oil, and alkali, and must be dry.

181. PAINTING METAL SURFACES.

a. If metal parts are in need of cleaning, they should be washed in a liquid solution consisting of one-half pound of SODA ASH in 8 quarts of warm water, or an equivalent solution, and then rinsed in clear water and wiped thoroughly dry. Wooden parts in need of cleaning should be treated in the same manner, but the alkaline solution must not be left on for more than a few minutes, and the surfaces should be wiped dry as soon as they are washed clean. When artillery or automotive equipment is in fair condition and marred only in spots, the bad places should be touched with ENAMEL, synthetic, olive-drab, lusterless, and permitted to dry. The whole surface will then be sandpapered with PAPER, flint, class B, No. 1, and a finish coat of ENAMEL, synthetic, olive-drab, lusterless, applied and allowed to dry thoroughly before the materiel is used. If the equipment is in bad condition, all parts should be thoroughly sanded with PAPER, flint, class B, No. 2, or equivalent, given a coat of PRIMER, synthetic, rust-inhibiting, and permitted to dry for at least 16 hours. They will then be sandpapered with PAPER, flint, class B, No. 00, wiped free from dust and dirt, and a final coat of ENAMEL, synthetic, olive-drab, lusterless, applied and allowed to dry thoroughly before the materiel is used.

182. PAINT AS A CAMOUFLAGE.

a. Camouflage is now a major consideration in painting ordnance vehicles, with rust prevention secondary. The camouflage plan at present employed utilizes three factors: color, gloss, and stenciling.

(1) COLOR. Vehicles are painted with ENAMEL, synthetic, olive-drab, lusterless, which was chosen to blend in reasonably well with the average landscape.

(2) GLOSS. The new lusterless enamel makes a vehicle difficult to see from the air, or from relatively great distances over land. A vehicle painted with ordinary glossy paint can be detected more easily and at greater distances.

(3) STENCILING. ENAMEL, synthetic, stenciling, lusterless, blue-drab, which does not photograph well, is used. The numbers are illegible at distances exceeding 75 feet.

b. Preserving Camouflage.

(1) Continued friction or rubbing must be avoided, as it will smooth the surface and produce a gloss. The vehicle should not be washed more than once a week. Care should be taken to see that the washing is done entirely with a sponge or a soft rag. High-pressure water and fender brushes must be used to clean chassis and suspension. The surface should never be rubbed or wiped, except while wet, or a gloss will develop.

(2) It is not desirable that vehicles painted with lusterless enamel be kept as clean as vehicles were kept when glossy paint was used. A small amount of dust increases the camouflage value. Grease spots should be removed with SOLVENT, dry-cleaning. Whatever portion of the spot cannot be so removed should be allowed to remain.

(3) Continued friction of wax-treated tarpaulins on the sides of a vehicle will also produce a gloss, which should be removed with SOLVENT, dry-cleaning.

(4) Tests indicate that repainting with ENAMEL, synthetic, olive-drab, lusterless, will be necessary once yearly, and with ENAMEL, synthetic, stenciling, lusterless, blue-drab, twice yearly.

183. REMOVING PAINT.

a. After repeated paintings, the paint may become so thick as to crack and scale off in places, presenting an unsightly appearance. If such is the case, remove the old paint by use of REMOVER, paint and varnish. It is important that every trace of paint remover be completely rinsed off and that the equipment be perfectly dry before repainting is attempted. Crevices or cracks in wood should be filled with putty and the wood sandpapered before refinishing. The surfaces thus prepared should be painted according to directions in paragraph 181.

184. PAINTING LUBRICATING DEVICES.

a. Oil cups, pressure fittings, oilholes, and similar lubricating devices, as well as a circle about three-quarters inch in diameter at each point of lubrication, will be painted with ENAMEL, synthetic, gloss-red, in order that they may be readily located. Do not paint openings in fittings through which lubricant passes.

Section XXV

REFERENCES

185. STANDARD NOMENCLATURE LISTS.

a. Unit, generating, M5 (for directors M5 and M5A1 and for seacoast uses) .... SNL F-227

Unit, generating, M6 (for directors M4 and M7 with data transmission system and for seacoast uses .... SNL F-227

Current Standard Nomenclature lists are as tabulated here. An up-to-date list of SNL's is maintained as the "Ordnance Publications for Supply Index" .... OPSI

186. EXPLANATORY PUBLICATIONS.

a. Maintenance and Inspection.

Cleaning, preserving, lubricating, and welding materials and similar items issued by the Ordnance Department .... TM 9-850

Detailed lubrication instructions for ordnance materiel .... OFSB 6-series

Echelon system of maintenance................ TM 10-525

Field inspection of ordnance materiel by service command inspectors in continental U. S...... TB 1100-1

Fire prevention, safety precautions, accidents.... TM 10-360

Hand measuring, and power tools............. TM 10-590

Instruction guide: Generating unit M5......... TM 9-2616

Instruction guide: Generating unit M6......... TM 9-2617

Instruction guide: The instrument repairman.... TM 9-2602

Maintenance and repair .... TM 10-520

Ordnance maintenance: Remote control systems M1 and M5 .... TM 9-1643

Tune-up and adjustment .... TM 10-530

37-mm A.A. gun materiel.................... TM 9-235

40-mm automatic gun M1 and 40-mm antiaircraft gun carriage M2 .... TM 9-252

b. Miscellaneous.

Camouflage	FM 5-20
Chemical decontamination materials and equipment	TM 3-220
Defense against chemical attack	FM 21-40
Fuels and carburetion	TM 10-550
List of publications for training	FM 21-6
Ordnance storage and shipment chart—Group F—major items	OSSC F
The internal combustion engine	TM 10-570
Welding, theory and application	TM 9-2852

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[A.G. 062.11 (8 May 43)
O.O. 461/40267 O.O. (2 Aug 43)]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:
J. A. ULIO,
Major General,
The Adjutant General.

DISTRIBUTION: R 9(4); Bn 9(2); C 9(8)

(For explanation of symbols, see FM 21-6.)

RAPD8OCT43- 87M

PUBLICATIONS DIVISION, RARITAN ARSENAL.

NOTES

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NOTES

WAR DEPARTMENT TECHNICAL MANUAL
TM 9-1617

This Technical Manual supersedes TB ORD 74 in so far as it applies to TM 9-1617. TB ORD 74 remains in effect until it is incorporated in other affected manuals or specifically rescinded.

ORDNANCE MAINTENANCE

GENERATING UNIT M18

WAR DEPARTMENT • 16 NOVEMBER 1944

RESTRICTED *DISSEMINATION OF RESTRICTED MATTER*— **No person is entitled solely by virtue of his grade or position to knowledge or possession of classified matter. Such matter is entrusted only to those individuals whose official duties require such knowledge or possession. (See also paragraph *23b*, AR 380-5, 15 March 1944.)**

WAR DEPARTMENT

Washington 25, D. C., 16 November 1944

TM 9-1617, Ordnance Maintenance: Generating Unit M18, is published for the information and guidance of all concerned.

[A.G. 300.7 (3 Oct 44)
O.O. 461/57117 Misc.]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

J. A. ULIO,
Major General,
The Adjutant General.

DISTRIBUTION: Armies (10); Corps (10); SvC (10); Depts (10); D (2); IBn 9 (2); IC 9 (3); Tech Svs (2); Arm & Sv Boards (2); P, C, or Stas (1); Gen & Sp Sv Schools (10); Ord Decentralized Sub-O (3); PE's "Mark for Ord O" (5); Ord Dist O (5); Ord Reg O (3); Ord Dist Br O (3); Ord Establishments (5).

IBn 9—T/O & E 9-65; 9-76.

IC 9—T/O & E 9-7; 9-9; 9-57; 9-67; 9-318; 9-377.

(For explanation of symbols, see FM 21-6.)

CONTENTS

CONTENTS (Contd.)

RESTRICTED

This manual supersedes TB ORD 74 in so far as it applies to TM 9-1617. TB ORD 74 remains in effect until it is incorporated in other affected manuals or specifically rescinded.

CHAPTER 1

INTRODUCTION

1. SCOPE.

a. This Technical Manual is published for the information and guidance of ordnance maintenance personnel. It contains detailed instructions for inspection, disassembly, assembly, and repair of the Generating Unit M18, supplementary to those in the Field Manuals and Technical Manuals for the using arm. Service operations, such as removal and installation of many accessories which are covered in TM 9-617, are omitted from this manual.

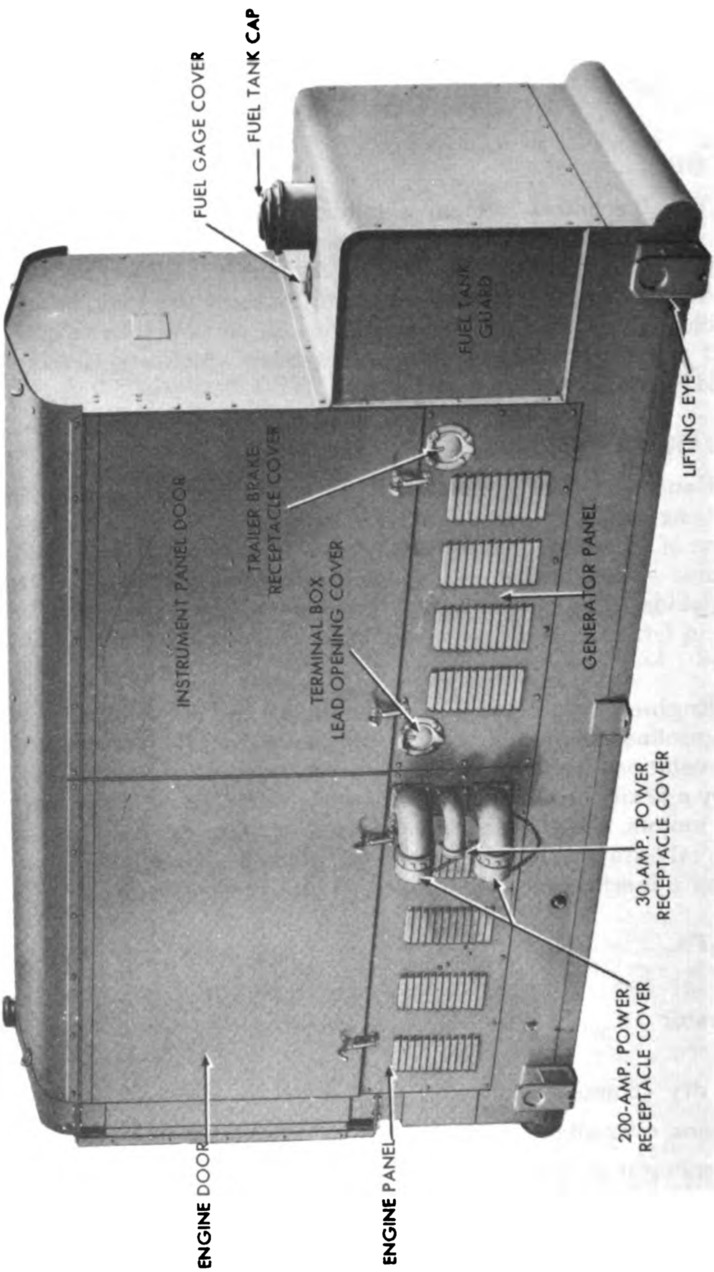
2. CHARACTERISTICS.

a. General. The Generating Unit M18 (figs. 1, 2, and 3) is a gasoline-engine-driven generator used to provide electric current for operation of a battery of antiaircraft guns. It is mounted on a welded-steel frame either for use on a specially designed trailer or set upon wooden skids. The radiator end of the unit is considered the front. Right and left sides are determined from the rear, facing toward the radiator.

b. Engine (figs. 2 and 3). The engine is a six-cylinder, water-cooled gasoline engine, developing approximately 67 horsepower at 1,200 revolutions per minute. It is directly connected to the a-c generator by a flexible coupling. The engine is equipped with two electric starting motors, a battery charging generator with a two-charge regulator, an oil-bath air cleaner, and an oil filter. Engine speeds are controlled by a mechanical flyball-type governor.

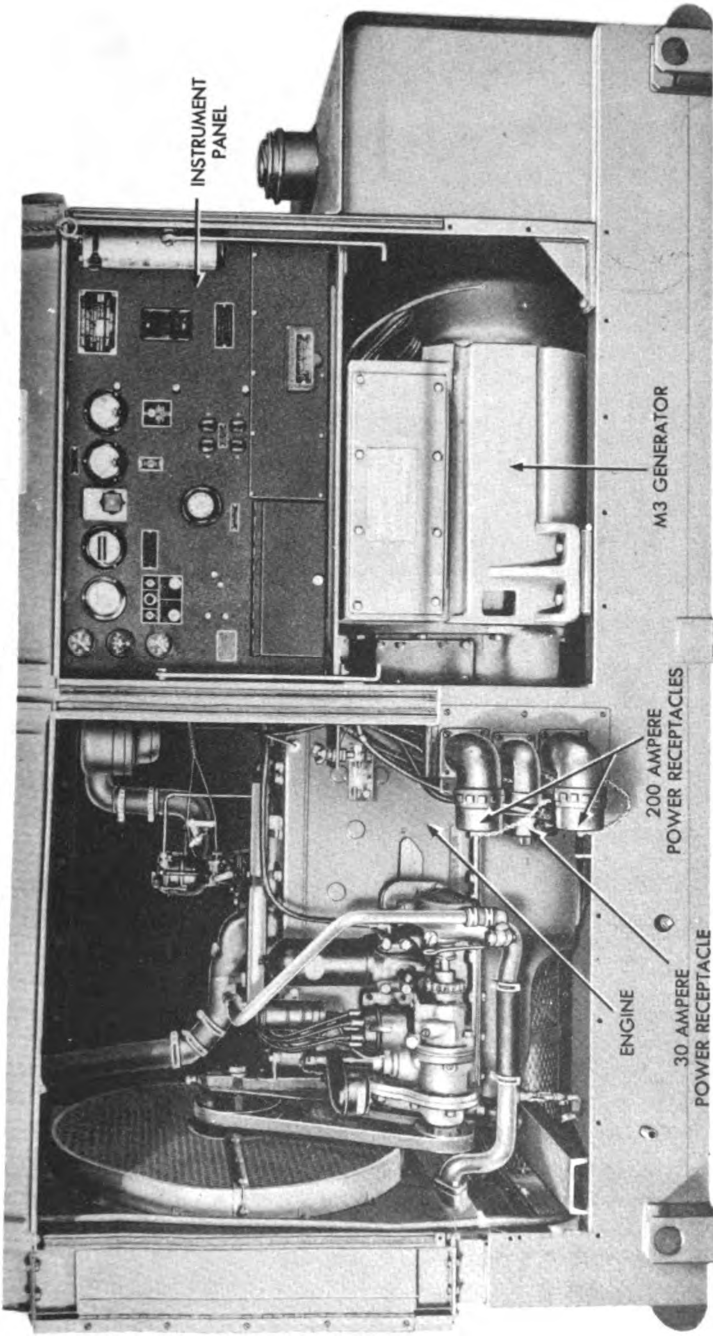
3. DATA.

Model:	
Generator	M3
Engine	Hercules WXLC-3
Weight, dry (complete unit)	4,194 lb
Dimensions, over-all	100½ x 41⅝ x 56⅝ in.
Rated generator output	30kw (80 percent power factor), 3-phase, 60-cycle, 125-volt; or 30kw (80 percent power factor), 3-phase 60-cycle, 250-volt



RA PD 78103

Figure 1—Generating Unit M18—Left Rear



RA PD 78545

Figure 2—Generating Unit M18—Doors Open and Panels Removed—Left Side

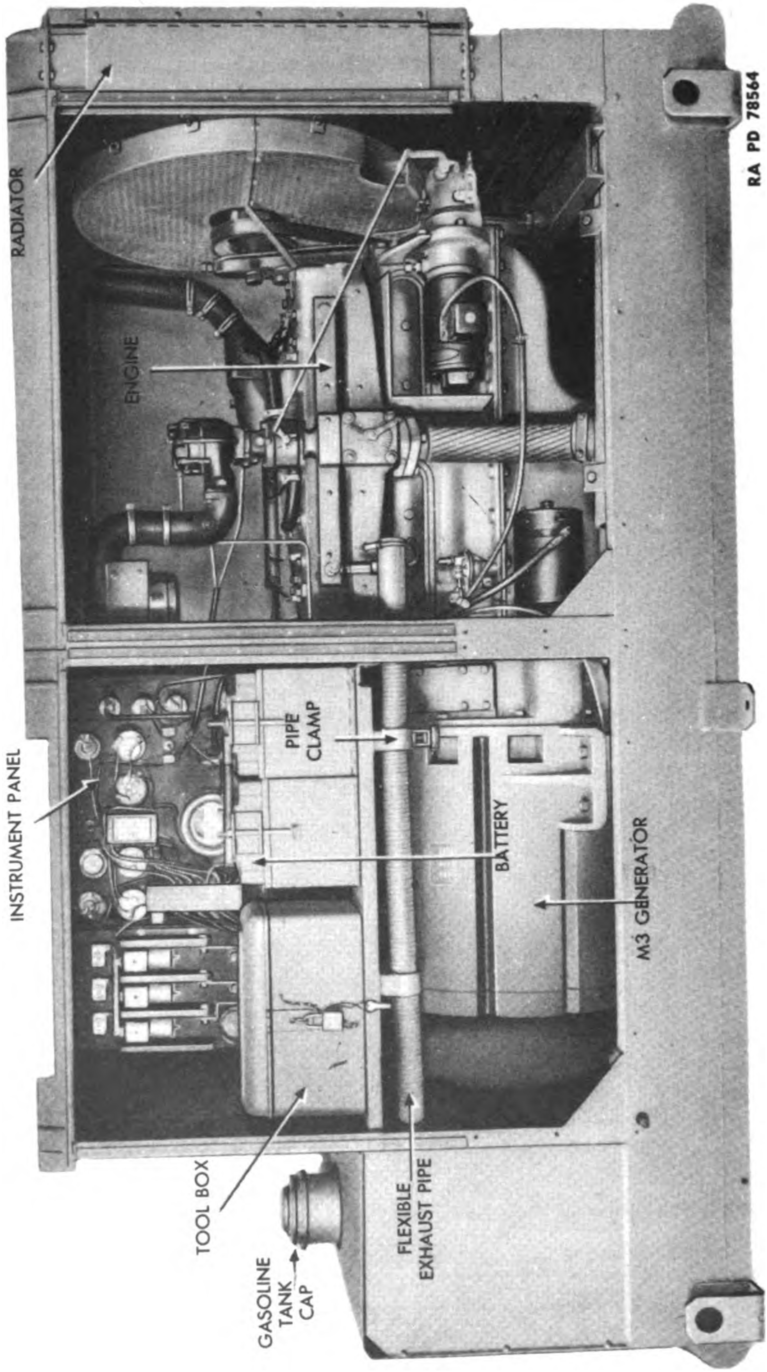


Figure 3—Generating Unit M18—Doors Open and Panels Removed—Right Side

CHAPTER 2

BASIC INSPECTION

4. GENERAL.

a. Scope. This section covers specific instructions for inspection by ordnance personnel of the materiel in the hands of troops, as well as instructions for higher echelons. General inspection instructions are contained in TM 9-1100, Inspection of Ordnance Materiel. The inspector should be well versed in maintenance procedures for the materiel and must have a working knowledge of the tools needed for its inspection.

b. Purpose.

(1) Fundamentally, inspection is for the purpose of determining whether or not the generating unit is serviceable, or the extent of its serviceability. Important but secondary purposes are the detection of incipient failure and the determination of whether or not proper care is being taken of the unit and accessories. Serviceability, as interpreted in this section, is the ability of the materiel to perform its intended functions completely.

(2) In the event the generating unit is unserviceable or incipient failures are disclosed, the cause and extent of the unserviceability will be determined. Such deficiencies as are found will be corrected on the spot or corrective measures will be taken. If the materiel must be "deadlined" or sent to a higher maintenance echelon for repair, it will be thoroughly and completely inspected, put into the best possible condition that time, materials, and tactical circumstances will allow, and returned to the using arm ready for immediate use.

c. Reports.

(1) Suggested improvements in design, maintenance, safety, and efficiency of operation, prompted by chronic failure or malfunction of the unit, spare parts, accessories, or equipment should be forwarded to the Office of the Chief of Ordnance, Field Service, Maintenance Division, with all pertinent information necessary to initiate corrective action. This information should be reported on WD AGO Form No. 468, Unsatisfactory Equipment Report. Such suggestions are encouraged so that other organizations may benefit from them.

(2) Report to the responsible officer any persistent carelessness or negligence in the observance of preventive maintenance procedures and safety precautions. This report should be accompanied by recommendations for correcting the unsatisfactory conditions. NOTE: *The inspector's aim is not to find fault with the using troops, but to be helpful.*

5. SPECIAL TOOLS.

a. Simplicity of design of the generating unit makes it possible to perform all repair operations covered in this manual with standard automotive equipment.

6. INSPECTION RECORD.

a. A permanent record, listing any maintenance performed, should be kept of each inspection. A suitable inspection form, with an itemized listing of the points of inspection, can be prepared locally as a guide for maintenance personnel. Utility of the form will be increased if space is provided to record the date, action taken, and remarks for each period of inspection.

7. ENGINE AND ACCESSORIES.

a. Engine Proper.

(1) Check exterior of engine oil pan, cylinder block, and cylinder head for cracks or leaks. Check for presence and condition of all gaskets. See that all cap screws and nuts are tight and equipped with lock nuts (if required).

(2) Test compression of engine (par. 10 **c**).

(3) Apply vacuum test to engine (par. 10 **d**).

(4) Run engine and observe functioning. Listen for piston slap, bearing knock, carbon knock, or other noises indicating malfunction.

b. Cooling System.

(1) Examine radiator for signs of leakage, bent fins, dirt in fins, dented or bent tubes or tanks, clogged overflow tube, nonfunctioning or missing doors, missing or poorly fitting radiator cap, and for dirt or rust in interior.

(2) Examine hose connection for leakage, loose clamps, or deterioration due to age. Feel hose for sponge-like deterioration on inside.

(3) Test operation of drain valve and inspect valve for leakage.

(4) Inspect water pump for cracks or leakage. Note position of water pump packing nut. If it is drawn up nearly to end of thread, need for repacking is indicated. Ascertain that shaft rotates freely.

(5) Inspect fan and bracket to see if either is broken or bent.

(6) Check fan belt for tension and for cracking, fraying, breaking, and to see if it is oil-soaked.

(7) Start engine to ascertain if cooling system functions properly. Remove radiator cap and see if coolant circulates properly after engine warms up and thermostat opens. Note fan to see if it vibrates or runs noisily.

BASIC INSPECTION

c. Battery Charging Generator and Regulator.

(1) Run engine and check functioning of charging system. Although a fully charged battery will cause the regulator to cut down charging rate, a charge should be shown by ammeter immediately after starting engine.

(2) Remove generator head band and check brushes for arcing. Stop engine and inspect brushes to see if they are broken or worn out (usable to one-half original length). Check spring tension of brush springs to see if they hold brushes snugly against commutator. Spring tension on collector brushes is 8 ounces per brush (minimum); on commutator brushes, 12 to 14 ounces. Notice if commutator is roughened. Inspect wiring to see if all connections are tight. Burned or scorched lead wires or coils indicate a short circuit. Test generator securing screw and lock washer for tightness.

(3) Remove cover from generator regulator. Check voltage regulator spring and circuit breaker springs to see that they are securely hooked to armatures and frames. Check resistor nuts and terminal screw for tightness. Check points to see if they are pitted or dirty. Check air gaps of armatures and contacts of voltage regulator and circuit breaker (par. 50 c). Remove screws which attach regulator to generator. Check terminal screws for tightness. Inspect all wires and coils to ascertain condition of insulation.

d. Ignition System.

(1) Test operation of spark coil (par. 53 a). Examine case and cover for cracks or damage from accident. Note condition of threads on terminals. Check for presence and tightness of lock washers and nuts on attaching screws and terminals.

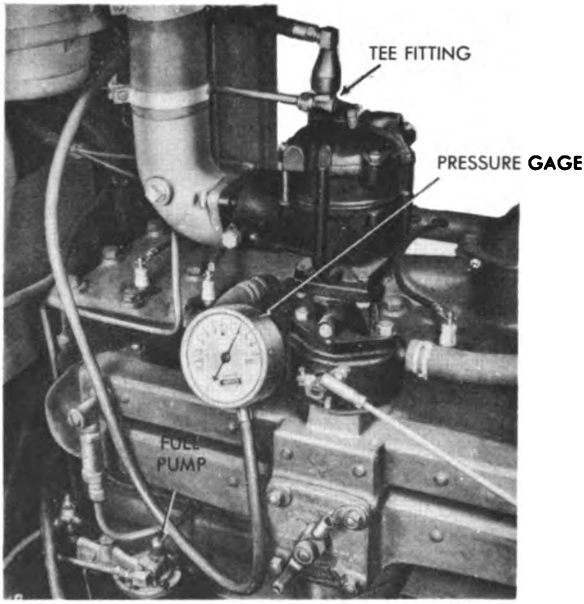
(2) Test and inspect spark plugs (par. 55 a).

(3) Remove distributor cap and inspect for presence of cracks, or burned or pitted cap inserts. Remove rotor and inspect for cracks and bent, scored, pitted, or worn contact spring and tip. Remove plate which covers points and condenser. Inspect breaker points for pitting or burning. Check breaker point gap, and set at 0.020 inch. Check cam for wear. Test shaft for side play indicating bearing wear, and for backlash indicating gear wear.

(4) Test distributor timing and adjust if necessary (par. 54 g).

e. Starting Motors and Batteries.

(1) Test action of starting motors. Check tightness of attaching cap screws and terminal nuts. Check for presence of lock washers on attaching screws and terminals. Remove head band. Check brushes to see if they arc, or are broken or worn out (usable to one-half original length). Test tightness of wire connections. See if commutator is scored or roughened.



RA PD 79571

Figure 4—Testing Fuel Pump Pressure

(2) Check batteries with hydrometer to see if they are fully charged and in good condition. Inspect cases for cracks, connections for tightness and corrosion, and wires for condition of insulation.

f. Fuel System.

(1) Check gasoline tank for presence and condition of filler cap, flame arrester screen, and fuel gage. Check for leaks. Check tightness of pipe plug and fuel line connections. Check for dents serious enough to impair strength or capacity of tank.

(2) Check fuel lines, drain and shut-off valves for security of attachment, for leakage, for functioning, and for tightness of all connections.

(3) Inspect fuel pump case and sediment bowl for cracks and leaks. Check tightness of body screws and attaching screws. Check for presence of lock washers on screws. Check for sediment, water, and dirt in sediment bowl and screen. In case of doubtful fuel pump action, disconnect pump to carburetor tube and connect a tee fitting into it. Connect a pressure gage to the tee fitting, start engine, and measure the pressure the pump develops (fig. 4). It should develop a minimum of 2 pounds pressure.

(4) Inspect carburetor for leaks and security of attachment. Test

operation of controls. Warm up engine and adjust idling mixture (TM 9-617).

(5) Examine throttle body to see if valve shaft rotates freely in bearings. Check body for cracks or leaks. Inspect water hoses for deterioration due to age or heat. Check tightness of hose clamps.

(6) Inspect air cleaner for security of attachment. Remove oil bowl and inspect for presence of vortex chamber and removable filter. Inspect all parts for dirt or sludge. Check tightness of hose clamps and condition of hose.

(7) Test governor action by running engine. It should hold engine at 1,200 revolutions per minute under full load, or 1,230 revolutions per minute with no load. Correct speed is indicated by 60-cycle reading on frequency meter. Check attaching screws, oil line, and lock nuts for tightness.

g. Exhaust System.

(1) Check exhaust tube and muffler for security of attachment, presence of insulating covers and insulation covers, and for presence of leaks.

(2) Inspect flexible exhaust pipe for breakage of flexible tube or clamp. Check flexible exhaust pipe guide and clamp (attached to under side of battery and tool box shelf) for security of attachment and proper functioning.

(3) Examine manifold to see if it is cracked or insecurely attached. Check manifold lever to see if it is in correct seasonal position ("HOT" for cold-weather operation; "COLD" for hot-weather operation).

h. Lubrication System.

(1) Warm up engine and check oil pressure. It should be 25 pounds at 1,200 revolutions per minute.

(2) Check oil lines and connections to governor and oil pressure gage for tightness and presence of leaks.

(3) Remove oil filter element and clean filter. Check oil passages in base and center tube for obstructions. Check felt washers which make up element to see if they are matted or torn.

(4) Remove, clean, and inspect oil strainer (par. 46). Check strainer gasket and oil pan gasket for damage permitting leakage.

8. GENERATING SYSTEM.

a. A-C Generator.

(1) Operate unit and check output. It should deliver 165 amperes at 125 volts, or 85 amperes at 250 volts.

(2) Remove fan guard and brush covers from rear of a-c generator. Operate unit and check brushes for arcing. Inspect alternator and exciter brushes to see if they are broken or worn out (one-half original length). Examine brush holders for weak springs. Springs must exert enough tension to hold brushes snugly against slip rings and commutator. Check brush lead wire connections for tightness (par. 85 **d** (16)). Inspect slip rings for scoring or pitting. Inspect commutator to see if bars are scored, pitted, burned, loose, or in a low or high position.

(3) Check generator to frame cap screws, and bell housing to generator cap screws for tightness and presence of lock washers.

b. Power Receptacles.

(1) Check tightness of connections of receptacle cables to terminals on back of load terminal box.

(2) Check for security of mounting and presence of covers on all three receptacles. Remove covers and inspect terminal insulators for cracks or dirt. Examine terminals to see if they are bent or corroded. Check receptacle bodies for fractures.

c. Load Terminal Box.

(1) From front of instrument panel, check tightness of door and box attaching screws and knurled screw door handle. Open door and check for presence of nut on each of the four connectors. Note condition of insulating bushing.

(2) From rear of instrument panel, test tightness of nuts which attach bus bar and cables to load terminal box. Check for presence of lock washers.

9. INSTRUMENT PANEL.

a. Check tightness of mounting bolts.

b. Check panel for dents or tears especially at screw holes.

c. Check instruments and controls for proper functioning.

d. Check tightness of all instrument and control attaching screws. Inspect screws for presence of lock washers where required.

e. Examine all connections of wires or tubes to instruments and controls for tightness. Inspect insulation on all wires on rear of panel to see if it has been injured or if it has deteriorated from age.

f. Test the three fuses on back of panel.

CHAPTER 3

GENERAL MAINTENANCE

Section I

TUNE-UP AND PERIODIC MAINTENANCE

10. TUNE-UP.

a. General. One of the most important operations in engine maintenance is frequent and proper tune-up. This operation, more than any other, contributes to maximum engine performance and economy. Ordinarily the engine should not be permitted to operate in excess of 150 hours without a complete tune-up.

b. Procedure. In order to avoid hit-and-miss methods, perform tune-up operations in order listed below.

c. Compression (fig. 5).

(1) Before making any checks on an engine, it should be run for several minutes to warm it up and lubricate the valve mechanism. The compression of the engine should be checked first, because an engine with uneven compression cannot be tuned successfully.

(2) Turn off the ignition and open the throttle valve to the wide-open position. Remove all spark plugs.

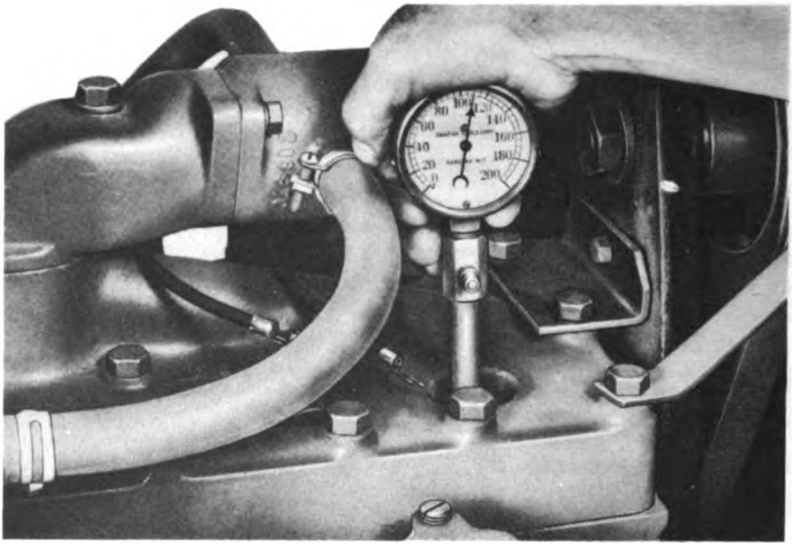
(3) Insert the compression gage in a spark plug hole, and hold it tightly in the hole. Crank the engine with the starting motor until the gage reaches its highest reading, which requires only a few turns. Repeat the same test on all cylinders, and make a note of the compression on each.

(4) The compression on all cylinders should be 110 pounds or better, and all cylinders should read alike, within 5 to 10 pounds, for satisfactory engine performance.

(5) Should there be a low compression reading on two adjacent cylinders, it indicates a possible inter-cylinder leak, usually caused by a leaking cylinder head gasket.

(6) If the compression readings are low or vary widely, the cause of the trouble may be determined by injecting a liberal supply of oil on top of the pistons of the low-reading cylinders. Crank the engine over several times, and then take a second compression test. If there is practically no difference in the readings when compared with the first test, it indicates sticky or poorly seating valves. If the compression reading on the low-reading cylinders is about uniform with the other cylinders, however, it indicates compression loss past the pistons and rings.

(7) The cause of low or uneven compression must be corrected before proceeding with an engine tune-up job.



RA PD 79552

Figure 5—Testing Compression

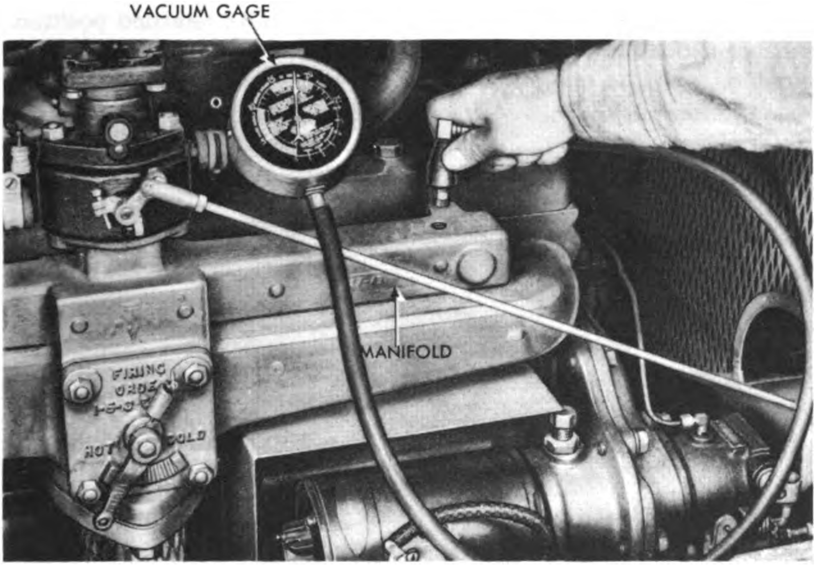
d. **Vacuum Test** (fig. 6). Remove one of the two pipe plugs on top of intake manifold and connect a vacuum gage to manifold. Start engine and run at idling speed until normal operating temperature is attained. A steady reading of 18 to 21 inches of vacuum at sea level indicates normal performance of engine at idling speed. If gage pointer fluctuates back and forth, a too rich or too lean fuel mixture is indicated. Adjust mixing screw at top of carburetor and throttle stop screw on side of carburetor to obtain maximum reading on vacuum gage and proper idling speed. If adjustment of carburetor does not cause normal reading of vacuum gage, and compression test indicated normal engine performance, remove and inspect carburetor (par. 15 b).

e. **Spark Plugs.**

(1) Clean the spark plugs thoroughly in a sand-blast spark plug cleaner. If the porcelains are badly glazed or blistered, replace the spark plugs. All spark plugs must be of the same heat range.

(2) Adjust the spark plug gaps at 0.025 inch, using a spark plug wire feeler gage. CAUTION: *Do not bend the center electrode.*

(3) Care must be used when installing the spark plugs, or the setting of the gap may be upset. When installing the plugs, screw the plug in fingertight, then tighten with the spark plug wrench one-half to three-quarters of a turn.



RA PD 79562

Figure 6—Testing Vacuum

f. **Battery Test.**

(1) Connect the negative terminal of a voltmeter to the starting switch terminal, and the positive terminal of the voltmeter to a good ground.

(2) Crank the engine for 15 seconds with ignition switch turned off. If the starting motor cranks the engine at a good rate of speed with the voltmeter reading 10 volts or better, it indicates a satisfactory starting circuit, which includes the condition of the battery, terminals, and cables. However, if the cranking speed is slow, or the voltmeter reading is under 10 volts, the starting motor, battery, and battery cable terminals must be checked individually to locate the source of the trouble.

g. **Distributor.**

(1) Remove the spark plug wires from the distributor cap and examine the terminals for corrosion. Inspect the wires for damaged insulation and for being oil-soaked.

(2) Remove the distributor cap, and check the cap and distributor rotor for cracks or burned contacts.

(3) Check the automatic advance mechanism by turning the distributor cam in a clockwise direction as far as possible, then re-

lease the cam and see if the springs return it to its retarded position. If the cam does not return readily, the distributor needs to be disassembled, and the cause of the trouble ascertained (par. 54).

(4) Examine the distributor breaker points; clean the points if they are dirty, replace points if they are pitted or worn. Check the points for alinement, and aline them if necessary.

(5) Hand-crank the engine until the cam follower rests on a peak of the cam. Adjust the point gap to 0.020 inch, using feeler gage. This operation must be performed very accurately. Hand-crank the engine until the cam follower is located between the cam peaks. Hook the end of a point scale over the movable point, and pull steadily on the spring scale until the points just start to open. Scale should read between 17 and 20 ounces. Adjust the point pressure by loosening the screw which holds the end of the contact arm spring, and slide the end of spring in or out as necessary.

(6) Reassemble distributor cap and spark plug wires. Make sure that the terminals of the primary wire from the ignition coil to the distributor are clean and tight.

h. Fuel Pump. Remove the sediment cup and screen and wash them thoroughly in dry-cleaning solvent. When assembling, make sure that the cork gasket between bowl and pump body is in good condition and is properly seated. Tighten all fuel pump connections. Test fuel pump output with fuel pump gage (par. 7 f (3)).

i. Air Cleaner.

(1) Remove and disassemble (par. 32 a) air cleaner.

(2) Empty the oil out of the cleaner, and clean out all oil and accumulated dirt. Wash body with dry-cleaning solvent, and wipe dry. Wash filter element by slushing up and down in dry-cleaning solvent. Dry thoroughly, either with an air hose or by letting it stand until dry. Refill the cup of the cleaner to bead level.

(3) Assemble and install air cleaner (par. 32 c).

j. Carburetor. Adjust mixing screw at top of carburetor until engine runs smoothly at idling speed. This screw controls the amount of air mixed with the fuel.

k. Ignition Timing. Attach one wire of a neon timing light to No. 1 spark plug, and the other wire to the No. 1 spark plug wire. Start the engine and run it at idling speed. Loosen distributor clamp and slowly rotate distributor body clockwise or counterclockwise until the "DC" mark on the flywheel is visible through the timing hole in the bell housing each time the light goes on.

l. Valve Tappet Adjustment. Adjust the valve tappets according to the procedure given in paragraph 72 g.

RA PD 79557

Figure 7—Scraping Carbon From Piston Head

m. Cooling System.

(1) Tighten all hose connections and examine for any indications of water leaks.

(2) Check the fan belt for cracks, oil-soaking, and for proper tension.

n. Oil Strainer. Drain oil pan strainer (par. 46).

11. 750-HOUR SERVICE.

a. After engine has been run for 750 hours, remove cylinder head and thoroughly clean out all carbon deposits.

b. Remove manifolds and clean out all deposits.

c. Remove all valves and clean out valve guides with dry-cleaning solvent and wire brush.

d. Clean and regrind intake valves, making sure all deposits and gums are cleaned off the valve stems and from under heads of the valves.

e. Reface exhaust valve seats in block. (If refaced valve seats are wider than one-eighth inch, they must be narrowed with a 45-

degree stone or tool, taking material off the inside port until 1/8-inch width of seat is secured.)

f. Replace exhaust valves with new valves. (If new valves are not available, the old ones can generally be reused after refacing in a grinder and thoroughly cleaning corrosion and deposits from the valve stems. Stems should then be polished with crocus cloth.)

g. Adjust tappet clearances to 0.010-inch intake and 0.016-inch exhaust. This is the first setting for a cold engine. After the engine has been run sufficiently to warm up, the clearances should be rechecked, and set to 0.006-inch intake, and 0.010-inch exhaust.

h. Clean heads of pistons and surface cylinder block of all carbon deposits (fig. 7). Flood piston tops with oil and turn over engine by hand. Wipe oil from cylinder bores when piston is at bottom of stroke. This is to remove fine particles of carbon which may work down between piston and cylinder wall during cleaning operation.

i. Install cylinder head, using new cylinder head gasket.

j. Install new spark plugs.

k. Install manifolds, using new gasket.

l. Clean radiator core with compressed air and brush, and install new fan driving belt, if required.

m. Install new distributor points and set gap at 0.020 inch. Lubricate the cam and pivot point of the new breaker arm, and check spring tension on the arm (par. 10 **g**). Set ignition timing on top dead center (par. 54 **g**).

n. Dismantle and clean carburetor jets and check float mechanism and needle valves (par. 33 **a**).

o. Assemble and install all accessories and connections, start engine, and warm up at idling speed until engine reaches normal operating temperature.

p. Recheck valve tappets and adjust to 0.006-inch intake and 0.010-inch exhaust.

q. Install valve cover plates, using new cork gaskets. (Use gasket cement on valve cover side only.) NOTE: *It is assumed that such parts as oil filter and air cleaner will be thoroughly washed and serviced, and that the lubricating oil will have been drained and replenished.* It is not necessary to remove the crankcase at this time unless there is evidence of loose bearings; or, due to dusty conditions or neglect of air cleaner servicing, the cylinder and pistons show abnormal wear.

Section II

TROUBLE SHOOTING

12. GENERAL.

a. This section contains trouble shooting information and tests which can be made to help determine the causes of some of the troubles that may develop in this generating unit. Information given here is more complete than that given in TM 9-617. Each symptom of trouble given under the individual unit or system is followed by a list of possible causes of the trouble. Tests necessary to determine which one of the possible causes is responsible for the trouble are explained after each possible cause. Repairs which will correct the deficiencies are suggested.

13. ENGINE.

a. Engine Will Not Turn.

(1) HYDROSTATIC LOCK (WATER IN CYLINDER). Remove spark plugs from cylinders and attempt to turn engine with hand crank. If engine turns, the lock will be relieved.

(2) STARTER DRIVE MECHANISM JAMMED. Remove and inspect both starting motors (par. 57). Replace Bendix drive if gear is worn. Install starting motors.

(3) INCORRECT OIL VISCOSITY. Drain engine and refill with proper lubricant (TM 9-617).

(4) SEIZURE DUE TO INTERNAL DAMAGE. Remove engine from unit (par. 58). Disassemble engine (par. 60) and inspect components.

b. Engine Turns; Will Not Start.

(1) INOPERATIVE FUEL SYSTEM. Open shut-off valves in gasoline line at tank and at fuel pump. Disconnect fuel line from carburetor. With ignition off, turn engine with starting motors. Unless fuel flows freely from line, fuel is not reaching carburetor (par. 15 **a**).

CAUTION: *Avoid gasoline spilling on engine by catching it in a clean container.*

(2) INOPERATIVE IGNITION SYSTEM. Remove the cable from spark plug. Hold cable terminal one-quarter inch from cylinder head casting. Turn on ignition switch and crank engine. Ignition is inadequate if spark fails to jump the 1/4-inch gap. Check points, condenser, and/or coil.

(3) SLOW CRANKING SPEED. Replace batteries.

c. Engine Does Not Develop Full Power.

(1) IMPROPER IGNITION. Refer to paragraph 19.

(2) INADEQUATE COOLING. Refer to paragraph 14.

(3) IMPROPER VALVE CLEARANCE. Check valve clearance and adjust if necessary (par. 72 q).

(4) IMPROPER FUEL. Drain fuel system and refill with clean gasoline.

(5) PREIGNITION. If preceding steps fail to reveal cause of malfunction, spark plugs of improper heat range may be the cause of the trouble. Replace spark plugs with proper type plug.

(6) AIR LEAKS AT CARBURETOR OR MANIFOLD FLANGES. With engine running at approximately 800 revolutions per minute, apply a small amount of oil at carburetor gaskets and flanges. If oil is sucked in, an air leak is indicated.

(7) INCORRECT GOVERNOR SETTING. Disconnect governor linkage rod at throttle body and check for sprung linkage or stuck throttle. If throttle and linkage operate freely, start and accelerate engine. If speed of 1,200 revolutions per minute (indicated by full generator output) is reached, a faulty governor adjustment is indicated. Adjust governor (TM 9-617). CAUTION: *Do not open throttle valve more than necessary to determine that the engine will develop 1,200 revolutions per minute with governor disconnected. Excessive engine speed may damage engine and/or generator.*

(8) LOW ENGINE COMPRESSION. Remove spark plugs and test compression with a compression gage. If readings vary by more than five pounds between cylinders, worn or damaged piston rings and/or valves, or a blown out cylinder head gasket is indicated. Remove cylinder head to determine fault.

(9) IMPROPER TIMING. Adjust according to paragraph 54 g.

d. Engine Misfires.

(1) FAULTY STARTING SYSTEM. Refer to paragraph 20.

(2) LOW ENGINE COMPRESSION. Refer to subparagraph c (8), above.

(3) INCORRECT CARBURETOR ADJUSTMENT. Adjust or repair carburetor (par. 33).

(4) CLOGGED FUEL TANK CAP VENT. Remove obstruction from vent or replace cap.

(5) RESTRICTED FUEL FLOW. Refer to paragraph 15 a and b.

(6) WATER IN FUEL. Drain fuel system and strain gasoline through chamois skin or other filter which will not permit water to pass.

(7) AIR LEAK IN INTAKE MANIFOLD OR CYLINDER HEAD. Apply oil to edges of gaskets and run engine. If oil is sucked in, a leak is indicated. Replace leaking gaskets and tighten nuts securely.

(8) CYLINDER HEAD GASKET DEFECTIVE, OR CRACKED WATER JACKET. Remove cylinder head from engine (par. 60 **a** (4)) and inspect gasket, cylinder walls, and cylinder head. Replace gaskets or cylinder head if defective. Replace cylinder block if cracked.

e. Engine Vibrates Excessively.

(1) MOUNTINGS LOOSE. Check tightness of screws which attach front engine support to frame, and generator to engine and generator to frame. Tighten loose screws.

(2) ENGINE MISFIRING. Refer to subparagraph **d**, above.

f. Knock in Engine.

(1) SPARK ADVANCED EXCESSIVELY. Check distributor timing. Time if necessary (par. 54 **g**).

(2) CARBON DEPOSITS IN CYLINDERS. Remove cylinder head (par. 60 **a** (4)) and clean carbon from head and cylinder block.

(3) LOOSE PISTON PINS. Disassemble engine and replace piston pins (pars. 60 **a** (11) and 70 **c**).

(4) LOOSE OR WORN ROD BEARINGS OR MAIN BEARINGS. Disassemble engine (par. 60) and inspect all bearings. Replace worn parts.

(5) CONNECTING RODS MISALINED. Disassemble engine and connecting rods. Aline or replace misalined rods (par. 70).

(6) END PLAY IN CAMSHAFT. Loosen lock nut on camshaft end play adjusting screw at front end of engine. Tighten end play adjusting screw so as to barely feel shaft, then back off one-quarter turn. Tighten lock nut.

(7) VALVE TAPPETS LOOSE. Adjust valve clearance to 0.006-inch intake and 0.010-inch exhaust (hot engine).

(8) FLYWHEEL LOOSE. Remove engine from unit (par. 58). Take off nuts which attach flywheel to crankshaft. Inspect threads of nuts and bolts carefully. Replace parts having damaged threads and install flywheel tightly. Install new cotter pins through bolts and nuts.

g. Grinding or Scraping Noise in Engine.

(1) BATTERY CHARGING GENERATOR BEARINGS WORN. Replace generator (par. 49 **a**).

(2) WATER PUMP BEARINGS WORN. Replace water pump (par. 30).

(3) BROKEN PISTON OR PISTON RINGS. Disassemble engine and

inspect piston and piston rings. Replace broken and worn parts (par. 70 b).

14. COOLING SYSTEM.

a. Engine Overheats.

(1) INSUFFICIENT COOLANT. Fill cooling system and inspect hose connections, radiator, and gaskets for evidence of leakage. Replace faulty parts and tighten loose connections.

(2) RADIATOR DIRTY ON INSIDE OR OUTSIDE. Drain and flush cooling system (par. 27). Blow dirt from radiator fins with compressed air.

(3) CLOGGED COOLING SYSTEM. Flush system. If trouble persists, disconnect radiator from engine and reverse-flush engine and radiator (par. 27).

(4) THERMOSTAT STUCK CLOSED. Replace thermostat.

(5) WATER PUMP INOPERATIVE. Drain system and remove plug from top of pump. Crank engine and observe impeller action through plug opening. Repair or replace pump if impeller does not turn.

(6) FAN BELT SLIPPING. Adjust fan belt to proper tension. Inspect belt and replace if greasy.

(7) FAULTY IGNITION. Refer to paragraph 19.

b. Engine Slow To Warm Up.

(1) THERMOSTAT STUCK OPEN. Replace thermostat.

15. FUEL SYSTEM.

a. Fuel Does Not Reach Carburetor.

(1) LACK OF FUEL. Check quantity of fuel in tank. Replenish supply if depleted.

(2) SHUT-OFF VALVES CLOSED. Open shut-off valves in gasoline line at tank and at fuel pump.

(3) GASOLINE TANK CAP VENT CLOGGED. Remove obstruction from vent, or replace cap.

(4) INOPERATIVE FUEL PUMP OR CLOGGED FUEL LINES. Disconnect carburetor lines from fuel pump. Crank engine. If fuel flows from pump, an obstruction is in carburetor line. If fuel fails to flow from pump, remove tank line from fuel pump. If fuel flows from tank line, a faulty fuel pump is indicated. Repair or replace pump, if faulty (par. 36). If fuel fails to flow from tank line with both shut-off valves open, an obstructed line is indicated. Remove line and blow out with compressed air.

b. Fuel Does Not Reach Engine.

(1) CARBURETOR CLOGGED. Disassemble, clean, inspect, and repair carburetor (par. 33 a).

(2) THROTTLE NOT OPENING. Disconnect governor linkage rod from throttle body. Start engine and operate throttle manually. This will free throttle if stuck. If throttle works satisfactorily, a defective governor is indicated. Disassemble and repair defective governor (par. 35 a). CAUTION: *Do not allow engine to develop speed in excess of 1,200 revolutions per minute while operating throttle manually.*

c. Gasoline Leaks From Fuel Pump.

(1) LOOSE SEDIMENT BOWL. Tighten bowl retaining nut on wire bail.

(2) DEFECTIVE SEDIMENT BOWL GASKET. Replace gasket.

(3) LOOSE FUEL LINE NUTS. Tighten fuel line nuts. Replace nuts if threads are stripped.

(4) BROKEN FUEL PUMP DIAPHRAGM. This condition is indicated if fuel drips from bottom of pump. Replace diaphragm if damaged (par. 36 a).

d. Fuel Pump Delivers Less Than 2 Pounds Pressure.

(1) STUCK VALVE. Remove air dome and valve cap and lift valve springs and valve from seat. Clean valve seat and springs. Replace damaged parts.

(2) AIR LEAKS IN SYSTEM. Tighten all connections.

(3) DIAPHRAGM, DIAPHRAGM SPRING, OR LEVER BROKEN. Disassemble fuel pump and inspect all parts carefully. Replace broken or worn diaphragm (par. 36 a).

e. Excessive Fuel Consumption.

(1) AIR CLEANER FOULED. Service air cleaner.

(2) CARBURETOR IMPROPERLY ADJUSTED. Adjust or repair carburetor (par. 33).

(3) CARBURETOR FOULED. Disassemble carburetor (par. 33). Clean and inspect all parts. Be sure to remove obstruction from all passages.

f. Gasoline Leaks From Carburetor.

(1) LOOSE SCREWS OR WORN GASKETS. Tighten screws. If leak persists, disassemble carburetor and repair or replace carburetor (par. 33).

(2) NEEDLE VALVE WORN OR NOT SEATING PROPERLY. Remove

carburetor cover and check for dirt under needle valve. Repair needle valve or replace carburetor (par. 33).

(3) DEFECTIVE FLOAT. Remove carburetor cover and inspect float. Repair float if defective (par. 33).

(4) CHOKE VALVE CLOSED. Open choke valve. If stuck, disconnect control from carburetor and ascertain if control or valve is at fault. Free up or replace sticking parts.

16. EXHAUST SYSTEM.

a. Exhaust Fumes in Engine Compartment.

(1) FAILURE TO USE FLEXIBLE EXHAUST PIPE. Attach flexible exhaust pipe to muffler before starting engine.

(2) LOOSE OR LEAKING MANIFOLD GASKET OR CRACKED MANIFOLD. Inspect manifold. Replace manifold it cracked. Tighten manifold if loose. Replace manifold gaskets if leaking.

(3) EXHAUST TUBE LOOSENED FROM MANIFOLD OR MUFFLER. Inspect exhaust tube attachment at both ends. Tighten loose nuts. Replace companion flange gasket if it leaks after tightening.

(4) UNSERVICEABLE EXHAUST TUBE OR MUFFLER. Remove insulation from exhaust tube and muffler (pars. 41 **a** and 42 **a**). Inspect tube and muffler to see if seams are open, or if metal is corroded. Replace unserviceable muffler.

17. ENGINE LUBRICATION SYSTEM.

a. Low or No Oil Pressure.

(1) INSUFFICIENT OIL. Check oil on oil gage stick. Add oil to bring to "4/4" mark. Visually inspect external oil lines for leaks.

(2) LOW OIL PRESSURE AFTER ENGINE WARMS UP. Start engine, if oil pressure is normal while engine is cold but starts to drop while it is warming up, loose connecting rod and/or main bearings is indicated.

(3) OIL PRESSURE GAGE INOPERATIVE. Disconnect gage and temporarily connect line to a gage known to function properly. Start engine. Normal functioning of test gage indicates defective gage installed on instrument panel. Replace gage if defective.

(4) PRESSURE RELIEF VALVE STUCK OR SET TOO LOW. Watch pressure gage; turn oil pressure adjusting screw and check for variation of pressure. No change in pressure indicates defective relief valve. Disassemble relief valve and inspect parts. Adjust valve if out of adjustment.

(5) IMPROPER VISCOSITY OIL. Drain oil and fill crankcase with seasonal grade oil.

(6) Oil Strainer Clogged. Remove oil strainer from oil pan (par. 46 a). Clean strainer screen with dry-cleaning solvent.

(7) Oil Pump Gears Worn. Remove oil pump from engine (par. 47 a). Disassemble pump and inspect parts (par. 47 b). Replace worn and damaged gears.

18. BATTERIES AND GENERATING SYSTEM.

a. Battery Discharged.

(1) Switches Left on When Not in Use. Turn off switches when not in use. If ignition switch was left on, check condition of distributor breaker points.

(2) Generator Inoperative. Start engine and observe charging rate on ammeter. If no charge is shown with engine operating and with partially discharged battery installed in unit, a blown regulator fuse, faulty wiring, or inoperative generator or two-charge regulator is indicated. Trace wiring from generator to battery, noting condition of insulation. Test fuse in voltage regulator. Replace or repair defective wiring and replace defective fuses. If cause of trouble still has not been located, remove cover from two-charge regulator. With engine running, hold contact points of cut-out together, hold voltage regulator points closed, and observe ammeter. If charge is shown, a defective voltage regulator is indicated. If no charge is shown, a defective generator is indicated. Disassemble defective components. Clean and inspect all parts, replace unrepairable parts (generator, par. 49 a; two-charge regulator, par. 50 b).

(3) Battery Shorted Internally. Test cells of batteries with hydrometer and with a high-rate discharge instrument. If any cell (or cells) is appreciably lower than the rest, an internal short in that cell (or cells) is indicated. Replace batteries which are shorted internally.

(4) Grounded or Shorted Circuits. Install fully charged batteries in unit. Connect ground only. With all switches off, touch positive wire to positive post and watch for sparks. If sparks are observed, inspect wiring for damaged insulation. Replace faulty wires. Failure to locate trouble by above test indicates that trouble is in the ignition circuit. Trace wire from ignition switch to "IGN" terminal of terminal block, from terminal block to ignition coil, and from coil to distributor. Replace wires having damaged insulation. Failure to locate short circuit in wiring would indicate short circuit is in switch or coil. Replace or disassemble and repair defective units (switch, par. 105 b; coil, par. 53 a).

b. Ammeter Does Not Show Charge.

(1) Ammeter Inoperative. Disconnect ammeter and tem-

porarily connect an ammeter known to function properly. Run engine. If test ammeter shows charge, replace ammeter.

(2) LOOSE OR CORRODED CONNECTIONS OR BROKEN WIRES. Trace wiring from generator to regulator, to terminal block, to ammeter, to ignition switch, to terminal block, to ignition coil, to distributor. Clean and tighten all connections and repair broken wires in the circuit.

(3) GENERATOR AND/OR REGULATOR INOPERATIVE. Refer to subparagraph a (2), above.

c. Ammeter Shows Excessive Charge.

(1) TWO-CHARGE REGULATOR OUT OF ADJUSTMENT. Adjust regulator (par. 50 c).

(2) THIRD BRUSH IMPROPERLY ADJUSTED. Remove head band from generator and slide third brush in direction of armature rotation.

d. Ammeter Shows Discharge With Engine Running.

(1) TWO-CHARGE REGULATOR OUT OF ADJUSTMENT. Adjust two-charge regulator (par. 50 c).

(2) GENERATOR INOPERATIVE. Disassemble generator. Clean and inspect all parts. Replace unrepairable generator (par. 49 a).

(3) SHORTED CIRCUIT. Refer to short circuits in subparagraph a (4), above.

e. Ammeter Shows Heavy Discharge With Engine Stopped.

(1) SHORTED CIRCUIT. Refer to short circuits in subparagraph a (4), above.

(2) REGULATOR CIRCUIT BREAKER POINT STUCK. Disconnect batteries to stop discharge. Disassemble two-charge regulator; repair or replace assembly (par. 50).

(3) AMMETER HAND STICKING OR AMMETER BURNED OUT. Replace the instrument.

(4) GENERATOR CAPACITOR SHORT CIRCUITED (APPLIES ONLY TO UNITS HAVING RADIO NOISE SUPPRESSION SYSTEM). Disconnect lead wires of capacitors in "CG" circuit. One capacitor is mounted on load terminal box and other is mounted on generator. If discharge stops when either of capacitors is disconnected, a short is indicated in that capacitor. Replace shorted capacitors.

f. Ammeter Hand Fluctuates Rapidly.

(1) GENERATOR OR REGULATOR FAULTY. Refer to subparagraph a (2), above.

(2) SHORTED CIRCUIT. Refer to subparagraph a (4), above.

g. Ammeter Shows Low Charging Rate.

(1) BATTERIES FULLY CHARGED. Test batteries with hydrometer. Low charge rate is normal if batteries are fully charged. This is due to action of two-charge regulator functioning normally.

(2) THIRD BRUSH IMPROPERLY ADJUSTED. Remove head band from generator and slide third brush in direction opposite armature rotation.

(3) HIGH RESISTANCE IN CHARGING CIRCUIT. Clean and tighten battery terminals and check circuits for loose or corroded connections. Clean and tighten all dirty or loose connections.

(4) DIRT ON COMMUTATOR. Remove head band from generator and inspect commutator. If dirt is in evidence, clean commutator by applying flint paper to commutator while engine is running.

h. Generator Noisy at Idle Speed.

(1) DRY FAN BELT. Hold a piece of graphite lubricant against belt for a moment, with engine running.

(2) LOOSE POLE PIECE SCREW. Remove generator from engine and tighten pole pieces securely.

(3) COMMUTATOR DAMAGED. Disassemble generator and replace armature (par. 49 **a**).

(4) BROKEN BEARING. Disassemble generator and replace broken bearing (par. 49 **a**).

19. IGNITION SYSTEM.

a. Engine Fails To Start; Ammeter Shows Pulsating Discharge.

(1) NO SPARK AT SPARK PLUG. Inspect coil to distributor high-tension wire. Connect wire if disconnected, and replace if broken.

(2) WEAK SPARK. Clean and adjust distributor points (par. 54). If spark is still weak, replace condenser (par. 54 **b** (2)). If trouble persists, replace coil.

(3) DISTRIBUTOR CAP CRACKED. Carefully inspect distributor cap. Small cracks, often invisible in poor light, are sufficient to cause shorts. Replace cap if cracked.

(4) GROUNDED DISTRIBUTOR ROTOR. Replace rotor as indicated in paragraph 54 **b**.

(5) DEFECTIVE SPARK PLUG CABLES. Visually inspect cables. Replace if defective.

(6) DEFECTIVE SPARK PLUGS. Replace spark plugs.

b. Engine Fails To Start; Ammeter Shows Constant Normal Discharge While Engine Is Being Cranked.

(1) DEFECTIVE OR GROUNDED COIL TO DISTRIBUTOR WIRE. Inspect wire and replace if damaged.

(2) DEFECTIVE BREAKER POINTS. Clean or replace distributor breaker points and adjust gap (par. 54 b).

(3) DEFECTIVE CONDENSER. Remove and check condenser.

(4) DEFECTIVE COIL. Replace coil.

(5) DEFECTIVE DISTRIBUTOR. If trouble persists, a defective distributor is indicated. Disassemble distributor (par. 54 b). Clean and inspect parts (par. 54 c). Replace unrepairable distributor.

c. Engine Fails To Start; Ammeter Shows No Discharge.

(1) BREAKER POINTS FAULTY. Check for pitted or dirty breaker points. Clean or replace points and adjust gap to 0.020 inch.

(2) OPEN CIRCUIT IN IGNITION SYSTEM. Remove spark plug from wire and hold one-quarter inch from cylinder head casting. Turn on ignition and crank engine. Absence of spark indicates an open circuit. Trace two wires from distributor to ignition coil, one wire from coil to terminal block "IGN" terminal, one wire from terminal block to ignition switch, and one wire from ignition switch to ammeter. Tighten loose connections and replace broken wires. If no open circuit exists in wiring or connections, a faulty ignition switch or coil is indicated. Replace these assemblies, one by one, until faulty unit is discovered.

(3) DISTRIBUTOR FAULTY. If procedure outlined in step (1), above, failed to eliminate trouble, a faulty distributor is indicated. Replace unrepairable distributor.

20. STARTING SYSTEM.

a. Starting Motors Will Not Operate.

(1) BATTERIES DISCHARGED. Test batteries with a hydrometer. Recharge or replace if discharged.

(2) STARTER SWITCH INOPERATIVE. Short-circuit terminals on bottom of starter switch. If starting motors operate, a faulty switch is indicated. Replace switch. NOTE: *Use a heavy wire or bar when shorting terminals to prevent excessive heating.*

(3) FAULTY WIRING. If batteries are fully charged and starter switch is operative but current does not reach starting motors, faulty wiring is indicated. Inspect wiring, tighten loose connections, and replace broken wires.

(4) STARTING MOTORS INOPERATIVE. Connect positive lead of voltmeter to starting motor terminal. Ground voltmeter negative lead to frame. Depress starter switch and observe voltmeter reading. If 12-volt reading is obtained and starting motor tested does not function, starting motor is inoperative. Test each starting motor in this manner. Disassemble inoperative starting motors (par. 57 a). Replace unrepairable starting motor.

b. Starting Motors Operate and Engage Flywheel but Do Not Turn Engine.

(1) BATTERIES DISCHARGED. Check batteries with a hydrometer. Recharge or replace discharged batteries.

(2) HYDROSTATIC LOCK IN CYLINDER. Hydrostatic lock is discussed in paragraph 13 a.

(3) BENDIX GEAR DAMAGED OR STUCK. Remove starting motor from engine and Bendix drive from starter (par. 57 a). Clean and inspect drive. Replace defective parts.

c. Slow Cranking Speed.

(1) HIGH ELECTRICAL RESISTANCE. Visually inspect starting motor and battery circuit to see if any terminals are loose or corroded or if undersize wires have been installed in circuit. Check operation of starter switch (subpar. a (2), above), and starting motors (subpar. a (4), above). Clean and tighten loose connections. Replace undersize wires with proper size wires; replace starter switch if test shows it to be faulty. Disassemble and repair starting motors if high resistance is indicated within them.

(2) ENGINE OIL TOO HEAVY. Drain engine and fill crankcase with proper lubricant.

(3) STARTING MOTORS BADLY WORN. This condition is indicated by excessive noise during operation of starting motors. Disassemble worn starting motors and carefully inspect all parts (par. 52). Replace unrepairable starting motor.

21. LIGHTING SYSTEM.

a. Instrument Panel 6-volt Light Will Not Burn.

(1) BURNED-OUT FUSE. Pull fuse from clips adjacent to small terminal block on back of instrument panel. Install a new fuse.

(2) BURNED-OUT LAMP. Remove lamp from socket and test with 6-volt current. Replace lamp if it fails to light.

(3) OPEN CIRCUIT IN WIRING OR SWITCH. Inspect wire from light switch. Replace if damaged; connect if disconnected. Short circuit terminals on rear of switch. A defective switch is indicated if lamp lights. Replace switch if defective. Trace wiring from switch to "63" terminal of small terminal block, from terminal block to fuse, from fuse to "61" terminal of terminal block, and from terminal block to battery. Clean and tighten corroded or loose connections. Replace broken wires.

b. Six-volt Light Burns Out Continuously.

(1) HIGH RESISTANCE IN BATTERY GROUND CIRCUIT. Inspect battery ground circuit cable. Clean and tighten its connections.

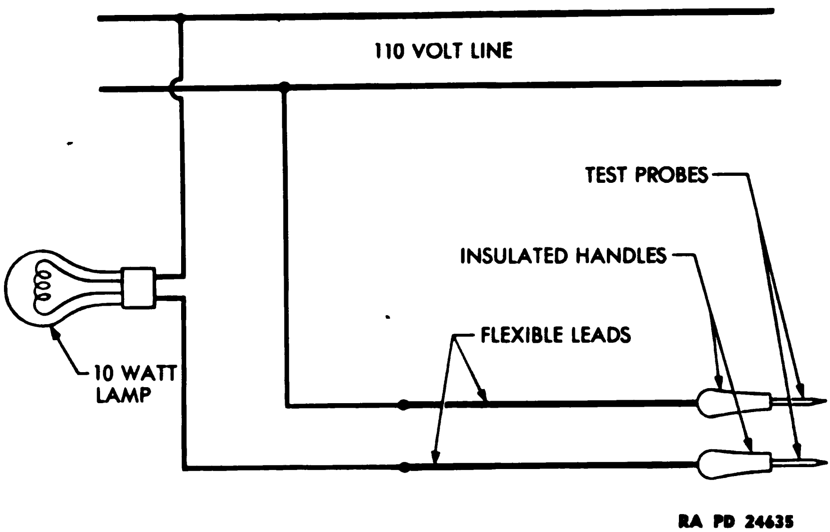


Figure 8—Test Lamp Diagram

(2) GENERATOR REGULATOR OUT OF ADJUSTMENT. Adjust regulator (par. 50 c).

22. A-C GENERATING SYSTEM.

a. General.

(1) TYPES OF MALFUNCTIONS. Three things can go wrong with coils or lead wires of a generator: open circuit, short circuit, and a ground.

(a) Open Circuit. An open circuit is caused by a break in a wire or by an opening of a connection between two wires. This breaks the circuit because the current has no path to follow.

(b) Short Circuit. A short circuit is caused by lack of insulation on two touching wires. This enables the current to take a "short cut" instead of traversing the route of its proper course.

(c) Ground. A ground is caused by lack of insulation on a wire or coil at point of contact with framework of generator. This allows the current to flow into the framework instead of following its proper course.

(2) CONSTRUCTION OF TEST LAMP (fig. 8). Connect in series a probe, a battery or other source of current, a lamp, and another probe. Test operation of test lamp by touching the points of the two probes together. The lamp should light.

(3) ISOLATION OF MALFUNCTION.

(a) Check for an Open Circuit. Place test lamp probes on bare

wire at extremities of wire or coil being tested. If the lamp lights, a continuous circuit is indicated. Failure of lamp to light indicates an open circuit.

(b) Check for a Short Circuit. No specific procedure which will apply in all cases can be given. Loss of generator power and presence of excessive heat indicate a short circuit.

(c) Check for a Ground. Place one probe of test lamp on bare metal of suspected coil or wire. Touch other probe to unpainted surface of generator frame. Lighting of test lamp indicates presence of ground. Failure of lamp to light indicates absence of ground.

b. Symptom—No Amperes at Rated Voltage.

(1) Turn circuit breaker "ON." Test for open circuit from "A" terminal of power receptacle to terminal at lower left (facing rear of instrument panel) of rear of circuit breaker panel. Repeat test from "B" terminal of power receptacle to terminal in bottom center of circuit breaker panel. Repeat test from power receptacle "C" terminal to lower right terminal on circuit breaker panel. Repair or replace wiring of any circuit on which test lamp fails to light.

(2) If the procedure indicated in subparagraph a (3) *(a)*, above, shows no open circuit, an open circuit is indicated in wiring to or within motor of appliance operated by unit.

c. Symptom—Excessive Amperes at Rated Voltage.

(1) Test for open circuit in "B" circuit (subpar. a (3) *(a)*, above).

(2) Test ammeter by disconnecting it and connecting into circuit an ammeter known to be good. Replace ammeter if it registers incorrectly.

(3) Check wiring and connections in "B" circuit (from "B" terminal of receptacle) to unit with test lamp. Look for open circuit or poor connections.

d. Symptom—Insufficient Amperes at Rated Voltage.

(1) Check links of generator terminal box to be sure they are properly connected.

(2) Check "A," "B," and "C" circuits from generator to receptacle with test lamp (subpar. a (3) *(a)*, above).

(3) Test wiring in circuit exterior to unit for short circuit, open circuit, and poor connections with test lamp. Repair or replace defective wiring.

(4) If above steps fail to reveal the cause, a defective motor on appliance being operated by unit is indicated.

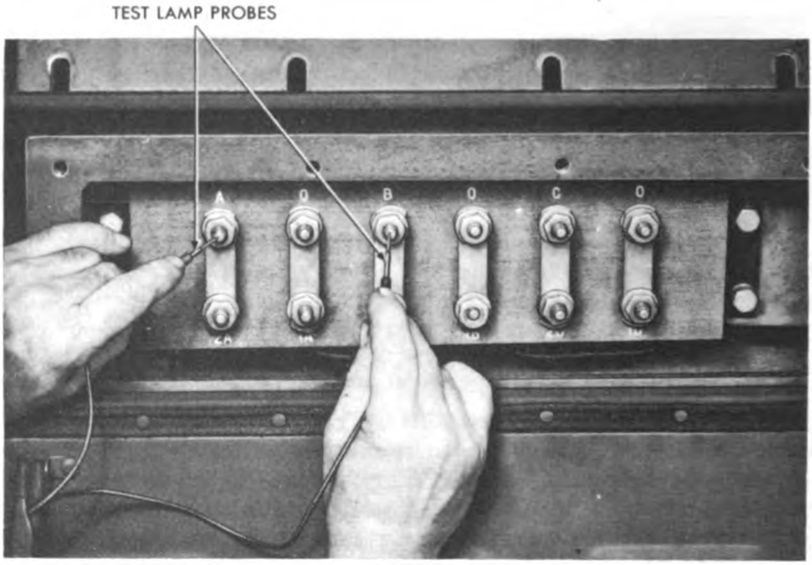


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Figure 9—Checking Generator Operation

e. **Symptom—No Amperes and No Voltage.**

(1) Start engine and turn on circuit breaker. Using a standard 110-volt trouble lamp, apply probes at terminals "A" and "B" of generator terminal box (fig. 9). Repeat the test from terminal "A" and "C" and then from terminal "B" and "C." Stop engine. Interpret results as follows:

(a) Lamp Lights on All Three Tests. Generator is functioning. Proceed with step (2), below.

(b) Lamp Fails To Light on Two of the Tests. Open circuit in stator or stator leads is indicated. Disassemble generator and repair stator, or replace frame and stator (par. 82).

(c) Lamp Fails To Light on All Three Tests. Proceed with step (3), below.

(2) Leave circuit breaker turned on. With a test lamp, test for an open circuit between generator terminal box terminal "A" and power receptacle terminal "A" (fig. 10). Repeat test from generator terminal box terminal "B" and power receptacle terminal "B." Repeat test from generator terminal box terminal "C" to receptacle terminal "C." Failure of lamp to light on any of above tests indicates an open in circuit being tested. The open circuit may be in links at generator terminal box, generator to circuit breaker wiring, cross-current compensating transformer ("A" phase only), circuit breaker

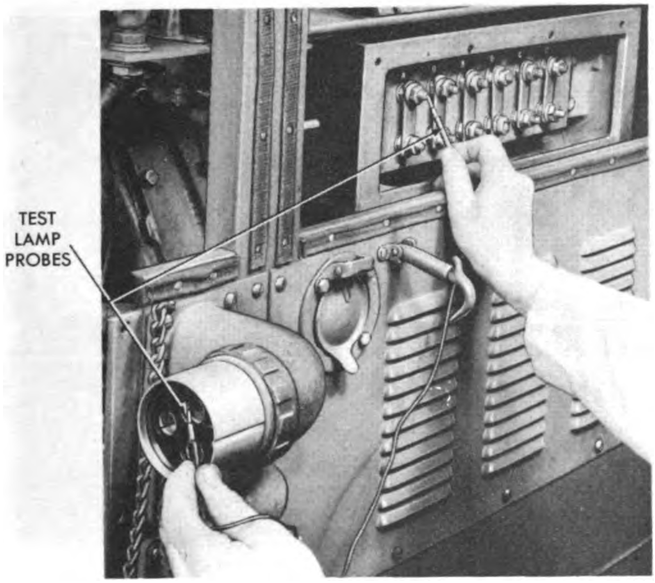


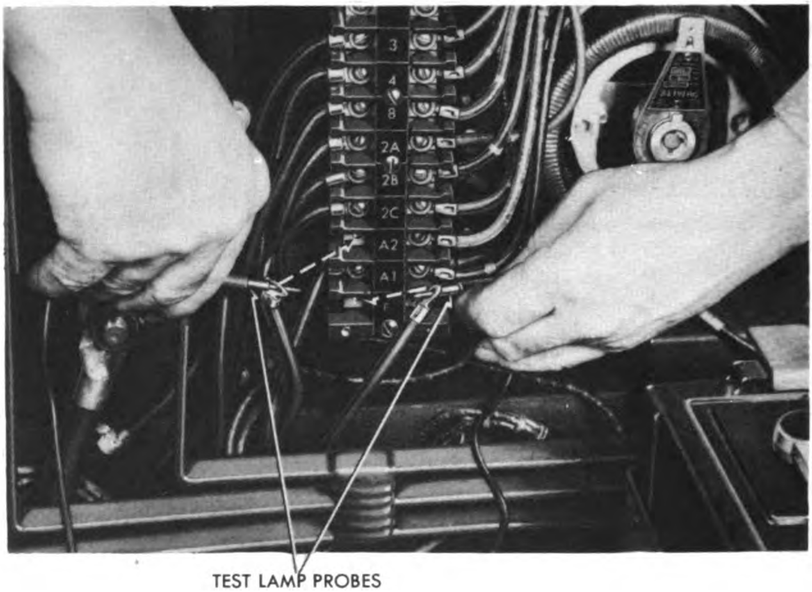
Figure 10—Checking Receptacle Circuit

to load terminal box bus bar, load terminal box to power receptacle cables, or in power receptacles. Test each unit, each wire, and across each connection of phase showing an open. Repair or replace defective parts.

(3) Remove links from generator terminal box. With test lamp, test for open circuit from terminals "A" to "B," "B" to "C," and "A" to "C." Failure of lamp to light on all three tests indicates an open in stator or stator leads. Disassemble generator and repair or replace stator (par. 82). If lamp lights on all three tests, proceed with step (4), below.

(4) Remove rear fan guard and brush covers. Lift all four slip ring brushes from slip rings so none make contact. Test for an open circuit between the two slip rings. Failure of lamp to light indicates an open in revolving field coils or lead wires. Disassemble generator and repair or replace defective rotor or wires (par. 82). If lamp lights, proceed with step (5), below.

(5) Start engine. Turn on field rheostat as far as it will go clockwise. Test exciter voltage by placing probes of direct current voltmeter on any two adjacent exciter commutator brush holders. At least 62.5 volts should register. Three results are possible: no



RA PD 78607

Figure 11—Checking Exciter Field Circuit

voltage, low voltage, or correct voltage. Proceed as follows, depending on results of test:

(a) No Voltage. Connect jumper wire between terminals "F" and "A1" on large terminal block on back of instrument panel. Repeat test. If voltmeter shows 62.5 volts, an open in voltage regulator, field rheostat, or wires to them, or wire from commutator brush to slip ring brush, is indicated. Check individual units, wires, and across connections for an open circuit. Repair or replace faulty units or wires. If voltmeter still shows no voltage, examine commutator brushes to see if they are broken, worn, or wedged in holders. Examine brush holder springs to see if ney hold brushes against commutator snugly. Replace faulty parts. Repeat test. If voltage is still absent, remove generator to terminal block leads from terminal block terminals "F" and "A2" (fig. 11). Test for open circuit from lead wire "F" to "A2" with test lamp. Failure of lamp to light indicates an open in exciter field circuit. Disassemble generator and repair or replace exciter field. If lamp lights, connect generator lead wire "F" to terminal block terminal "F," and disconnect generator lead wire "A1" from terminal block. Test for open from wire "A1" to wire "A2." Be sure slip ring brushes are lifted from slip rings during test. Failure of lamp to light indicates open in exciter armature circuit.

(b) Low Voltage. Follow procedure of step *(a)*, above. Look for a high resistance or loose connection, faulty resistor, faulty field rheostat, faulty voltage control, or short circuit in exciter field coil or armature. Shorted coils or armature usually shows signs of heat.

(c) Correct Voltage. Correct voltage relieves the exciter of responsibility. Test lead wires from commutator brush to slip ring brush, and from exciter field to commutator brush for open circuits. Repair or replace wires having open circuits. Test connections at ends of wires and brush contacts for open circuit.

f. Symptom—Excessive Sparking at Commutator Brushes.

(1) DIRTY OR PITTED COMMUTATOR. Inspect commutator. If dirty or moderately rough, clean by holding No. 00 class B flint paper against it while it is slowly revolving. If badly scored, disassemble generator (par. 82) and turn down commutator on a lathe (par. 84 c (3)).

(2) BROKEN OR WORN EXCITER BRUSHES. Inspect brushes; if broken or worn to length of ¾ inch or less, replace.

g. Excessive Heating of Generator.

(1) OVERLOADING. Decrease load to an allowable limit.

(2) OPEN OR GROUNDED COILS. Refer to subparagraph e, above.

h. Excessive Noise in Generator.

(1) WORN-OUT BRUSHES. Inspect brushes. Replace if broken or worn to length of ¾ inch or less.

(2) DAMAGED BRUSH SPRINGS. Inspect springs and test spring tension. Adjust tension if necessary. Spring tension on collector brushes is 8 ounces per brush (minimum); on commutator brushes, 12 to 14 ounces. Replace springs if bent, broken, or burned.

(3) COUPLING FAILURE. Disconnect generator from engine (par. 81). Remove and disassemble front fan (par. 82 b). Replace broken or worn parts.

(4) BROKEN BEARING. Remove exciter field and brush holder support bracket from rear of generator (par. 82 a). Pull bearing from rotor shaft (par. 82 g (1)). Replace bearing.

i. Voltage Regulator Malfunctions.

(1) GENERAL. Malfunctioning of voltage regulator is indicated if generating unit works correctly when being controlled by means of exciter field rheostat, but malfunctions when voltage regulator is brought into circuit.

(2) VOLTAGE WILL NOT BUILD UP.

(a) Check vibrator action. If vibrator does not vibrate, there may be a loose or open connection in regulator or potential transformer circuit. Test for open circuit with a test lamp to see if voltage is reaching coil of the voltage regulator.

(b) Remove box from rear of voltage regulator and check regulator contacts. Contacts may be in need of cleaning. Clean with an automotive-type distributor contact file if necessary.

(c) Check exciter field rheostat to make certain that resistance is all the way out of the circuit for automatic operation.

(d) Voltage adjusting screw may be turned too far in decrease voltage direction. Turn screw counterclockwise to see if voltage comes up.

(3) VOLTAGE REGULATOR EXERTS NO CONTROL OVER OUTPUT.

(a) Check on-and-off switch to see if it is in position for automatic operation. Check exciter field rheostat to see that it is turned clockwise as far as it will go.

(b) Check resistors on back of regulator panel for open or short circuit. Replace defective resistors.

(c) Check relay coil for open circuit or short circuit. If relay coil has no voltage, regulator will not operate. The normal operation voltage on the relay coil is 40 to 60 volts alternating current.

(d) Check vibrator and points to see if vibrator is bent, or if regulator contacts are stuck. Replace defective parts.

(e) Voltage adjusting screw may be turned too far in the increase voltage direction. Turn screw clockwise to decrease voltage.

(4) VOLTAGE BECOMES ERRATIC.

(a) The anti-hunt calibrating resistor may be out of adjustment. To increase anti-hunt effect, increase the resistance of the anti-hunt calibrating resistor. In adjusting this resistor, never cut out more than 50 percent of the resistance. After changing this resistor setting, it will be necessary to reset the voltage by means of the voltage adjusting screw.

(b) Too high a resistance in hunt field resistor will cause regulator to hunt. Proper setting for hunt field resistor is just below the setting which produces hunting. Too low a setting will cause the sensitivity of the regulator to be poor. This resistor is properly adjusted at the factory and will normally not require further adjustment.

(c) Check tightness of regulator connections and regulator lead wire connections. Ascertain that no screw or other mechanical part of the voltage regulator relay is loose.

(d) Check regulator contacts to see if they are built up, pitted, or stuck. Replace contacts if defective.

(e) Relay air gap will sometimes affect the stability of the regulator. Check air gap and adjust if necessary. Reduce air gap to $\frac{1}{16}$ inch if necessary to eliminate holding.

(5) VOLTAGE SENSITIVITY IS POOR.

(a) Make sure that the exciter field rheostat resistance is completely out of the circuit (turned all the way to the right).

(b) Check voltage regulator to see if any screw or mechanical part of the relay has come loose. Tighten loose parts. Check all voltage regulator connections to see if any are loose. Clean and tighten loose connections.

(c) Check air gap between vibrator and core. Adjust to $\frac{1}{32}$ inch Check contacts to see if they are built up, pitted, dirty, or worn. Clean, reface, or replace contacts as necessary.

(d) Check setting of the shunt field resistor in regulator. Too low a setting will decrease sensitivity. Increase as necessary.

(6) VOLTAGE DROPS EXCESSIVELY WITH INCREASE IN GENERATOR LOAD.

(a) Check regulator switch to be sure it is on.

(b) Check exciter field rheostat to be certain it is entirely cut out (knob turns to right as far as it will go).

(c) If neither of the above possibilities is at fault slightly increase the resistance of the shunt field rheostat.

(7) CONTACTS SPARK EXCESSIVELY.

(a) Check spark suppressor condenser to see if it is disconnected or open-circuited. A contact that does not spark may have a condenser with a short circuit in it. A contact whose spark is large (may show a yellow flame) may have a condenser that is open-circuited. A method of checking condensers is given in paragraph 118 f (5).

(b) Check lead wires between contacts and spark suppressor condensers to see if they are broken or have a loose connection. Replace broken lead wires. Clean and tighten loose connection.

(c) Check lead wire to shunt field resistor to see if it is broken or if a connection has come loose. Inspect resistor to see if it is burned out or broken. Replace defective parts. Clean and tighten loose connections.

(8) CONTACTS BUILT UP EXCESSIVELY. If capacity of spark suppressor condenser is too small, the cones on the contacts will build up blunt gray humps and the contact spark may tend to "flash over" at times. If condenser capacity is too large, the contacts will build up sharp dark humps and will tend to stick at times. Keep contacts smooth by filing them with a distributor contact file. If building up

reoccurs, replace spark suppressor condenser. NOTE: *Perfect contacts have a grainy metallic gray surface but are not necessarily smooth. Usually there is a dark ring around the edges.*

23. RADIO INTERFERENCE SUPPRESSION SYSTEM.

a. Unit Causes Radio Interference.

(1) IGNITION CIRCUIT NOISY. Accelerate engine and turn off ignition switch. If crackling noise stops the moment the switch opens, interference from ignition circuit is indicated. Check shield to see if it is tight and to see if all secondary circuit wires are inside shield. Test capacitors connected to "IGN" circuit at coil and at load terminal box (par. 125 b). Test spark plug suppressors and ignition coil suppressor (par. 126 b). Inspect shielded wire of ignition primary circuit to see if shielding is in good condition and grounded. Replace all parts which are in unserviceable or questionable condition. Clean spark plugs. Adjust ignition points. Clean and tighten all connections.

(2) TWO-CHARGE REGULATOR OR 125-VOLT VOLTAGE REGULATOR NOISY. An irregular clicking noise which continues for a moment after ignition switch is turned off indicates noise in two-charge regulator or 125-volt voltage regulator. Inspect points on both regulators. Replace if pitted or worn. Adjust armature and contact point gaps (two-charge regulator, paragraph 50 c; 125-volt regulator, paragraph 121). Test capacitors mounted on load terminal box and battery charging generator which are connected in "A," "B," "C," and "CG" circuits (par. 125 b). Replace faulty capacitors. Clean and tighten all connections.

(3) BATTERY CHARGING GENERATOR OR A-C GENERATOR NOISY. A whining noise which varies with engine speed and continues for a moment after ignition switch is turned off, indicates that one or both of the generators are noisy. Inspect brushes in both generators. Replace worn brushes. In case arcing is noted on a-c generator brushes, locate and correct the cause (par. 22 f). Inspect shielded wire in battery charging generator "CG" circuit to see if shielding is in good condition and grounded. Test capacitors in following circuits: "A," "B," "C," "O," and "CG" (par. 125 b). Replace unsatisfactory or questionable capacitors. Clean and tighten all connections in both generator circuits.

(4) GROUND CONNECTORS OR BOLTS LOOSE OR MISSING. An irregular crackling noise indicates lack of continuity of circuit throughout unit. Tighten all housing and frame nuts and screws. Clean and tighten connections of all six ground connectors. Replace all missing bolts, nuts, screws, and ground connectors.

CHAPTER 4

ENGINE AND ACCESSORIES

Section I

ENGINE (GENERAL)

24. DESCRIPTION (figs. 12 and 13).

a. **Cylinders and Main Bearings.** Cast integrally; the cylinder block and crankcase constitute the main frame of the engine. All cylinders are water-jacketed the full length of the bore. Seven main bearings support the crankshaft. These bearings contain babbitt-lined shells. The lower shell is secured in place by a drop-forged bearing cap. Each bearing cap is attached to the block with two or four bolts drilled for safety wire. The cylinder head is of the conventional L-type.

b. **Connecting Rods and Pistons.**

(1) Babbitt-lined, removable shells are used in the connecting rod bearings. Two alloy steel bolts and nuts locked in position with cotter pins secure each bearing cap to its connecting rod. The piston pin is clamped into the top of the rod by means of a screw. A notch in the pin is provided to receive the edge of the clamp screw. This device prevents the piston pin from working loose and scoring the cylinder walls.

(2) Aluminum pistons are used. No bearings or bushings are provided for the piston pin. Each piston has three compression rings and one oil ring. All rings are above the piston pin.

c. **Valves.** Removable valve guides are pressed into the cylinder block. Valve tappets are of mushroom type and are guided in removable clusters bolted to the crankcase. Replaceable exhaust valve seat inserts are used.

d. **Camshaft and Idler Shaft.** Large-diameter bronze bearings in the crankcase support the camshaft. These bearings are replaceable. The idler gear is supported on a shaft which, in turn, is supported on a removable bushing pressed into the crankcase.

e. **Manifold.** An intake and exhaust manifold of iron is cast in one piece. Exhaust gases pass through a space which surrounds the intake manifold.

f. **Water Pump Drive.** A water pump drive (accessory drive) on the left front side of the engine is the means of driving the water pump, distributor, and fan.

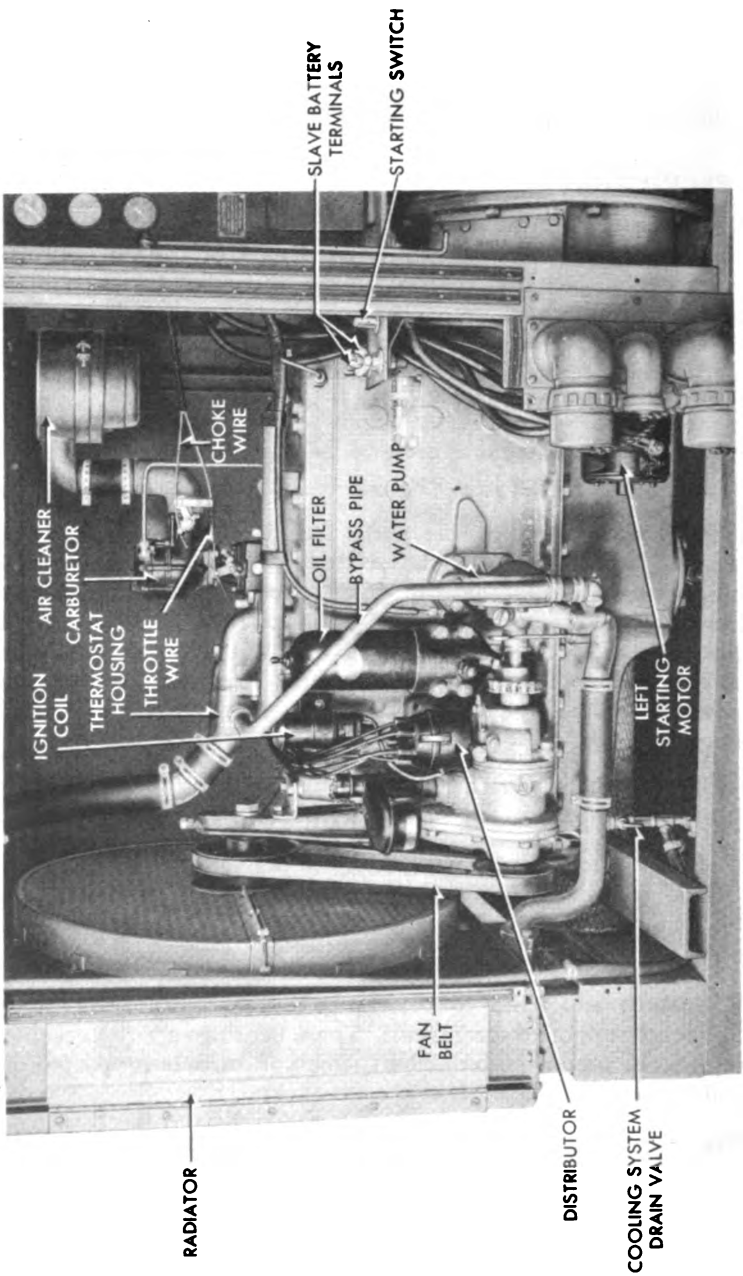


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Figure 12—Engine Installed—Left Side

ENGINE AND ACCESSORIES

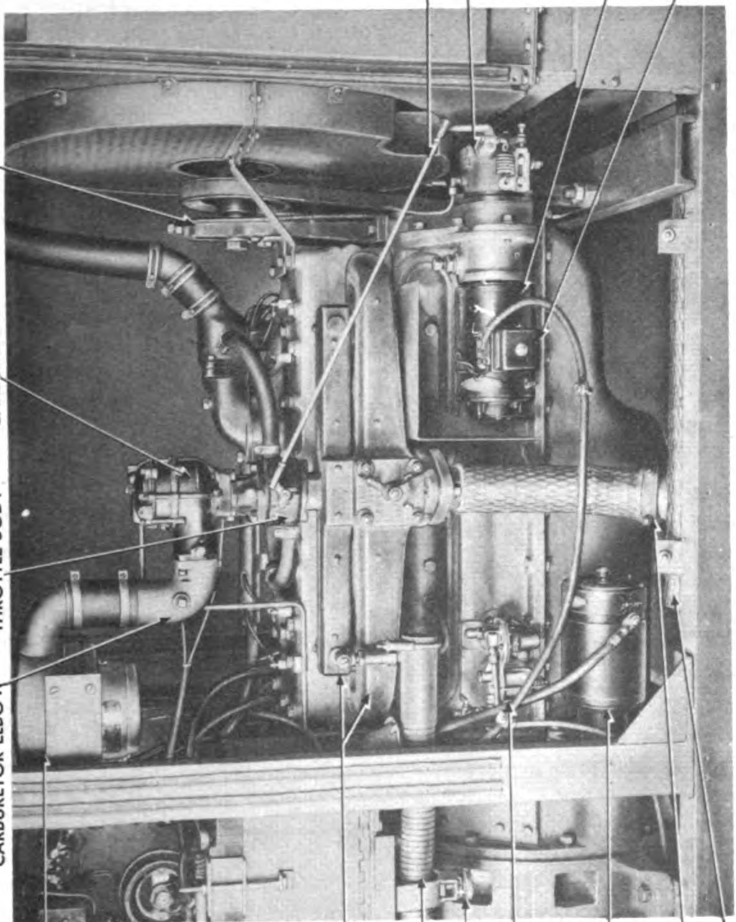

Figure 13—Engine Installed—Right Side

25. SPECIFICATIONS.

Bore	4¼ in.
Stroke	4¾ in.
Maximum horsepower at rated speed	67 hp at 1,200 rpm
Piston displacement	404 cu in.
Firing order	1-5-3-6-2-4
Lubrication	Forced feed to all connecting rod and main bearings, governor, and front camshaft bearings
Cylinder head:	
Type	Detachable
Valve arrangement	L-head
Exhaust port diameter	1½ in.
Intake port diameter	1⅝ in.
Pistons:	
Material	Aluminum
Number of oil rings	1
Number of compression rings	3
Oil ring width	$\frac{3}{16}$ in.
Compression ring width	⅛ in.
Piston pin diameter	1⅛ in.
Crankshaft:	
Number of bearings	7
Bearing diameter	2⅝ in.
Bearing length (front)	1¾ in.
Bearing length (center)	2¾ in.
Bearing length (others)	1½ in.
Camshaft:	
Drive	Helical gear
Location	Right side of cylinder block
Number of bearings	4
Bearing diameter	2⅛ in.
Bearing length (front)	1$\frac{5}{16}$ in.
Bearing length (center, 2)	⅞ in.
Bearing length (rear)	1⅜ in.
Connecting rods:	
Bearing diameter	2¼ in.
Bearing length	1⅛ in.
Connecting rod length (center-to-center)	9 in.
Carburetor:	
Model	Zenith 29B12
Size	1⅝ in. SAE
Type	Downdraft
Adjustment	Idling speed only

ENGINE AND ACCESSORIES

Generator:
- Model .... Auto-Lite, GFW 4808
- Voltage 12
- Mounting .... Right side of engine, behind governor
- Drive .... From timing gear
- Number of brushes 3
- Adjustment .... Third brush

Two-charge regulator:
- Model .... Auto-Lite, TC-4303D-2
- Voltage 12

Starting motors:
- Model .... Auto-Lite, MAS-4017
- Type .... 4-brush, Bendix drive
- Number used 2
- Voltage 12
- Mount .... Standard SAE on bell housing, one on each side of engine

Spark plugs:
- Model .... Champion No. 1, commercial
- Size .... 7/8-in. thread, 15/16-in. nut
- Gap .... 0.025 in.
- Firing order 1-5-3-6-2-4

Exhaust manifold bore .... 2½ in.

Method of suspension:
- Front .... One point
- Rear .... Bell housing attached rigidly to a-c generator frame

Fan:
- Number of blades 6
- Diameter of blades .... 27 in.
- Drive .... V-belt
- Bearings .... 2 roller

Water pump:
- Type .... Centrifugal
- Drive .... Chain coupling
- Bearing .... Bronze bushing
- Packing .... Split ring

Throttle body:
- Model .... King Seeley, 26759
- Type .... Butterfly valve, water-heated

Air cleaner:
- Make .... Vortox, 7545
- Type .... Oil bath

Governor:
- Manufacturer .... King Seeley Corp.
- Model .... King Seeley, 26765-323
- Type .... Mechanical, flyball
- Setting .... 1,200 rpm

Fuel pump:
- Model .... A-C, 1537763
- Type .... Diaphragm, with sediment bowl

Fuel lines:
- Material .... Copper
- Outside diameter .... $\frac{5}{16}$ in.
- Length (tank to pump line) .... $48\frac{13}{16}$ in.
- Length (pump to carburetor line) .... $43\frac{5}{16}$ in.
- Fittings .... Flared tube nut

Oil strainer:
- Model .... Hercules, 18145-BS
- Type .... Wire mesh

Oil filter:
- Model .... Michiana, HW
- Type .... Felt pad

Oil pump:
- Model .... Hercules, 18126-CS
- Type .... Submerged, spur gear

Ignition coil:
- Model .... Auto-Lite, CM406
- Voltage 12

Distributor:
- Model .... Auto-Lite, IGZ-4101M
- Type .... Automatic advance
- Rotation .... Clockwise (viewed from top)
- Point gap (max.) .... 0.020 in.
- Breaker arm spring tension .... 12 to 17 oz

Section II

COOLING SYSTEM

26. DESCRIPTION AND CONSTRUCTION.

a. **General** (fig. 14). The cooling system consists of a radiator, fan, water pump, thermostat, water passages in the cylinder block and head, and connections between these units. It has a capacity of 36 quarts. In addition, coolant is drawn from the system to the throttle body by hoses attached to fittings on the throttle housing and cylinder head. The purpose of running coolant through the throttle body is to prevent the butterfly valve from freezing in any position during cold-

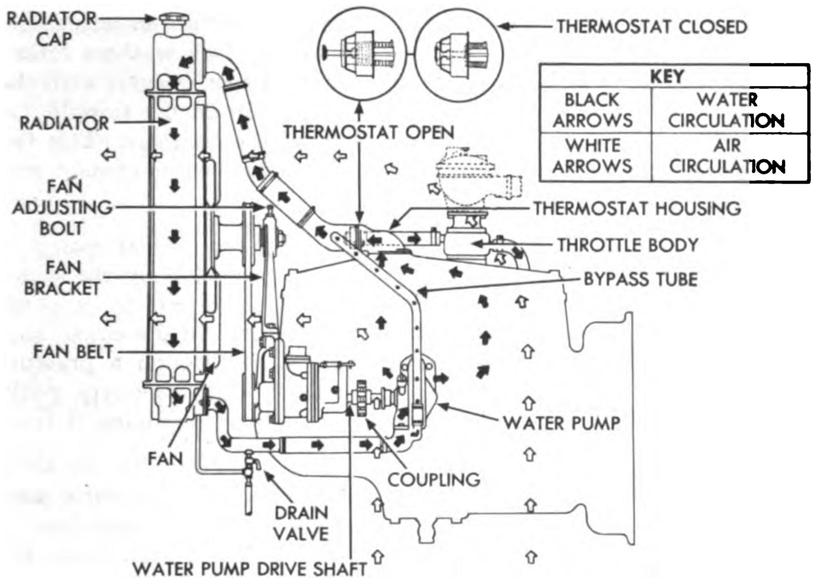

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Figure 14—Cooling System Diagram

weather operation. The function of the cooling system is to maintain an efficient operating temperature for the engine. Water, or other coolant, is cooled in the radiator by air forced through the core by the fan. The cooled water is drawn from the bottom of the radiator by the pump and forced through the water passages in the engine to the top of the radiator. While in the engine, the water absorbs heat and cools the engine. When the engine is cold, the thermostat remains closed. This shuts off the water from the radiator, and forces it to go directly from the top of the engine to the bottom of the water pump by way of the bypass tube. As the water increases in temperature, the thermostat opens and permits circulation from the engine to the radiator.

b. **Radiator** (fig. 14). A heavy-duty tractor-type radiator is used. It consists of a core, upper and lower tanks, and a fan shroud. Copper tubes and fins compose the core. Upper and lower tanks are made of welded sheet steel, and are bolted to the core. Six long steel rods tie the two tanks together in front of the core. They also serve to protect the core from external damage. A steel overflow tube is welded into the upper tank and extends down the rear left side of the core to the bottom of the radiator. A sheet steel fan shroud covers the rear of the core and is attached to the radiator side members with screws and lock washers.

c. **Fan** (fig. 14). A six-bladed fan is mounted on an adjustable bracket behind the radiator. Six cap screws and lock washers attach the blade assembly to a machined hub which is cast integral with the belt pulley. Two roller bearings support the hub on the spindle. A grease plug in the hub permits lubrication of the bearings. This fan is a pusher type; it draws air through the engine compartment and pushes it out through the radiator core.

d. **Water Pump** (fig. 14). A centrifugal-type water pump is mounted on the left side of the engine. It is propelled by the water pump drive (accessory drive) to which it is attached by a chain coupling. A bronze babbitt-lined bushing, mounted in the cover, supports the pump shaft. Lubrication is provided through a pressure grease cup. The impeller is keyed to the shaft. Split-ring type packing is used so the pump can be repacked without removing it from the engine.

e. **Hoses.** Various size hoses are used to interconnect the components of the cooling system. Dimensions of these hoses are as follows:

Upper radiator long hose:	
Inside diameter	2 in.
Length	12 in.
Upper radiator short hose:	
Inside diameter	2 in.
Length	3 in.
Lower radiator hose:	
Inside diameter	1½ in.
Length	8 in.
Bypass tube hoses:	
Number used	2
Inside diameter	1 in.
Length	2¼ in.
Throttle body front hose:	
Inside diameter	1$\frac{1}{16}$ in.
Length	12 in.
Throttle body rear hose:	
Inside diameter	1$\frac{1}{16}$ in.
Length	8 in.
Radiator to tee drain hose:	
Inside diameter	½ in.
Length	16 in.
Drain hose:	
Inside diameter	½ in.
Length	7 in.

27. MAINTENANCE.

a. Reference. For daily inspection, periodic inspection, antifreeze information, and cleaning instructions, refer to TM 9-617.

b. Corrective Service.

(1) CLEANING.

(a) Run the engine, radiator covered if necessary, until temperature reaches operating range. Stop engine, remove radiator cap, and drain system by opening drain cocks in radiator and block. Coolants containing ethylene glycol will be saved or discarded as outlined WD Circular No. 137, Section V, dated 16 June 1943.

(b) Allow engine to cool, close drain cocks, and pour the cleaning compound (Federal Stock No. 51-C-1568-500) into radiator in the amount of two cans to every 4 gallons of cooling system capacity. Fill system with water. Do not spill solution on paint. Place a clean drain pan to collect overflow and use to maintain level in radiator.

(c) Replace radiator cap and run engine at moderate speed, covering radiator if necessary, so that radiator core reaches a temperature of 180°F or higher, but not allow solution to boil. Run engine at this temperature for at least 2 hours. Stop the engine as often as necessary to prevent boiling.

(d) With the engine stopped, feel the radiator core with bare hand for cold spots, and watch temperature indicator. When there is no change in temperature for some time, drain the cleaning solution.

(e) If clogging of core is relieved but not fully corrected, allow engine to cool, pressure-flush the system (step (3), below) and repeat cleaning operation.

(f) If clogging of core, indicated by low-temperature spots on core, is not relieved, radiator core must be removed for mechanical cleaning. Mechanical cleaning may be accomplished by removing upper and lower tanks and rodding out the accumulated rust and scale from the water passages of the core.

(2) NEUTRALIZING.

(a) Allow engine to cool, close drain cocks, and pour neutralizer compound (Federal Stock No. 51-C-1568-500) into radiator in the amount of two cans to every 4 gallons of cooling system capacity. Fill system with water.

(b) Run engine, radiator covered if necessary, until solution is up to operating temperature.

(c) Drain by removing cap and opening all drains.

(3) FLUSHING (PRESSURE).

(a) Remove thermostat and hose connecting the engine block and radiator core.

(b) Clamp a convenient length of hose to radiator core outlet opening, and attach another suitable length of hose to radiator inlet opening to carry away flushing stream.

(c) Connect the flushing gun 40-G-540 to compressed air and water pressure, and clamp nozzle of gun in the hose attached to the radiator outlet opening.

(d) With radiator cap on tight, fill core with water. Turn on air pressure in short blasts to prevent core damage. Allow radiator to fill with water, and again apply air pressure as before. Repeat this process until water comes out clear.

(e) Clamp flushing gun nozzle firmly to a hose attached to engine water outlet opening. Fill engine with water. Turn on compressed air to blow out water and loosen sediment. Repeat filling with water and blowing out with air until flushing stream is clear.

(f) For badly clogged engine water jackets that do not respond to regular pressure flushing, remove cylinder head studs, accessible water jacket covers or core hole plugs and, with a suitable length of small copper tubing attached to flushing gun nozzle, flush jackets through those openings.

(g) After completing the flushing operation and before connecting cooling system hose, clean off all water connections of both radiator and engine block. Clean out radiator overflow pipe, inspect, and, if necessary, lubricate water pump, and clean thermostat. Blow insects and dirt from radiator core passages, using water if necessary to soften obstructions.

(4) LEAKS.

(a) After completing the flushing operation and before pouring the proper coolant in the cooling system, the entire cooling system must be examined for leaks. This is important because the cleaning solution uncovers leaks already existing but plugged with rust or corrosion.

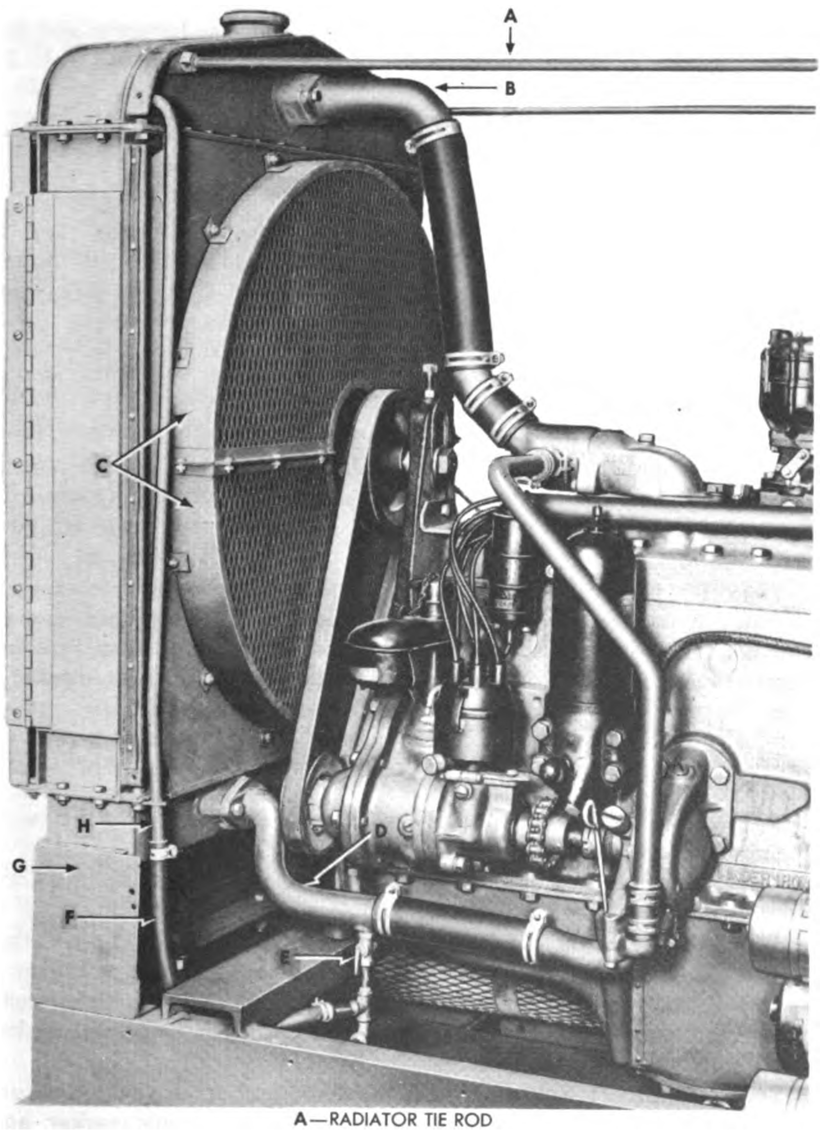
(b) Correct all leaks found, to avoid foaming, loss of solution, and corrosion. Check tightness of cylinder head joint, using torque indicating wrench.

(5) COOLANT SERVICE.

(a) When servicing for summer, refill system with clean water and add rust inhibitor (Federal Stock No. 51-C-1600). Use one container of inhibitor to each 4 gallons of cooling system capacity.

(b) When servicing for winter, refill system with clean water and with sufficient antifreeze for protection against lowest temperature likely to be encountered.

c. **Pre-disassembly Engine Maintenance.** The cooling system should be flushed before the engine is disassembled. Check the plugs



A—RADIATOR TIE ROD
B—RADIATOR INLET ELBOW
C—FAN GUARD
D—RADIATOR OUTLET ELBOW
E—DRAIN VALVE
F—RADIATOR TO TEE HOSE
G—RADIATOR BASE SUPPORT
H—OVERFLOW TUBE

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Figure 15—Radiator Removal Points

in the water jacket for leaks. If leaks are found, use hammer and flat punch, ½-face or larger, to drive the plug at the point of the leak. If, when reverse-flushing the system, too much pressure is used, the plugs may blow out. If this happens, put joint and thread compound (cement type B) around the seat, and drive in new plug with hammer and punch.

28. RADIATOR.

a. Removal (fig. 15).

(1) Remove canopy front side panels, all canopy doors, hood, and radiator doors.

(2) Remove fan guard.

(3) Drain cooling system.

(4) Disconnect radiator to tee hose from radiator overflow tube.

(5) Remove two cap screws and lock washers which attach radiator inlet elbow to radiator. Pull elbow free of upper tank, and remove gasket. Similarly disconnect radiator outlet elbow from lower tank.

(6) Remove the four cap screws and lock washers which secure radiator to radiator base support. Loosen lock nut on each end of the two horizontal radiator tie rods, and screw rods from radiator upper tank. Lift radiator and two pieces of webbing from support.

b. Disassembly (fig. 16).

(1) Test radiator for leakage before disassembling it (subpar. c, below).

(2) Turn radiator cap counterclockwise and lift from filler neck. Remove screw which attaches chain to cap.

(3) Remove the eight shroud-to-side-member screws and lock washers, and lift fan shroud from radiator.

(4) Remove nut and lock washer from each end of the six steel rods which extend from upper tank to lower tank in front of the core.

(5) Remove the 28 nuts, lock washers, and screws which attach upper tank to core and side members. Lift upper tank and gasket from core and side members.

(6) Remove the 28 nuts, lock washers, and screws which secure lower tank to core and side members. Lift lower tank, gasket, and the two side members from core.

(7) Back off lock nuts on the six steel rods on front of core. Lift rods and upper and lower strips from core.

c. Inspection.

(1) Before disassembly, test radiator for leaks as follows: Install a water outlet elbow gasket and a metal or wooden plate (screw holes drilled 3⅝ inches apart) over water outlet elbow opening in

lower tank. Attach a similar plate equipped with an air inlet valve over water inlet elbow in upper tank. Install filler cap securely on filler neck. Plug overflow tube. Submerge radiator in water and apply a maximum of 5 pounds air pressure to radiator. Watch for air bubbles which indicate leaks. CAUTION: *Do not use pressure in excess of 5 pounds.*

(2) After disassembly, clean radiator large parts with soap and water. Scrape residue from interior of tanks. Blow residue from core tubes with compressed air. Blow dirt from core fins with an air blast. Clean screws, nuts, and lock washers with dry-cleaning solvent.

(3) Test fit of filler cap on filler neck. Inspect tanks and side members to see if dents, cracks, or loosened welds are present. Examine overflow tube, which is welded to upper tanks, to see if it is bent, kinked, or broken. Inspect core to see if any fins are bent or if soldered connections have loosened. Examine radiator door hinges, which are welded to side members, to see if they are bent or broken. Examine all screws, lock washers, strips, and rods, to see if any are bent, broken, burred, or have stripped threads.

d. Repair.

(1) If radiator cap fits loosely, bend lugs to secure snug fit.

(2) Remove dents from sheet-steel parts by bumping. If heat is used, do not heat beyond cherry red. Examine parts carefully after straightening to be sure no breaks are present. Replace badly bent sheet metal parts.

(3) Weld or replace cracked or broken sheet metal parts. Sheet steel patches may be used if necessary.

(4) Straighten core fins, if bent. Use care to keep from puncturing tubes. Solder tubes if punctured or if they have come unsoldered.

(5) Remove burs from threaded parts and from attaching surfaces with a fine mill file. Clean up damaged threads with a tap or a die. Replace broken or stripped screws, nuts, and lock washers.

(6) Replace all gaskets.

e. Assembly (fig. 16).

(1) Position upper and lower strips and the six steel rods on front of radiator core. Tighten lock nuts on rods just sufficiently to hold parts in place.

(2) Position side members on radiator core. Using a new gasket, replace lower tank in position on core and side members. Install the 28 screws, lock washers, and nuts which attach tank to core and side members.

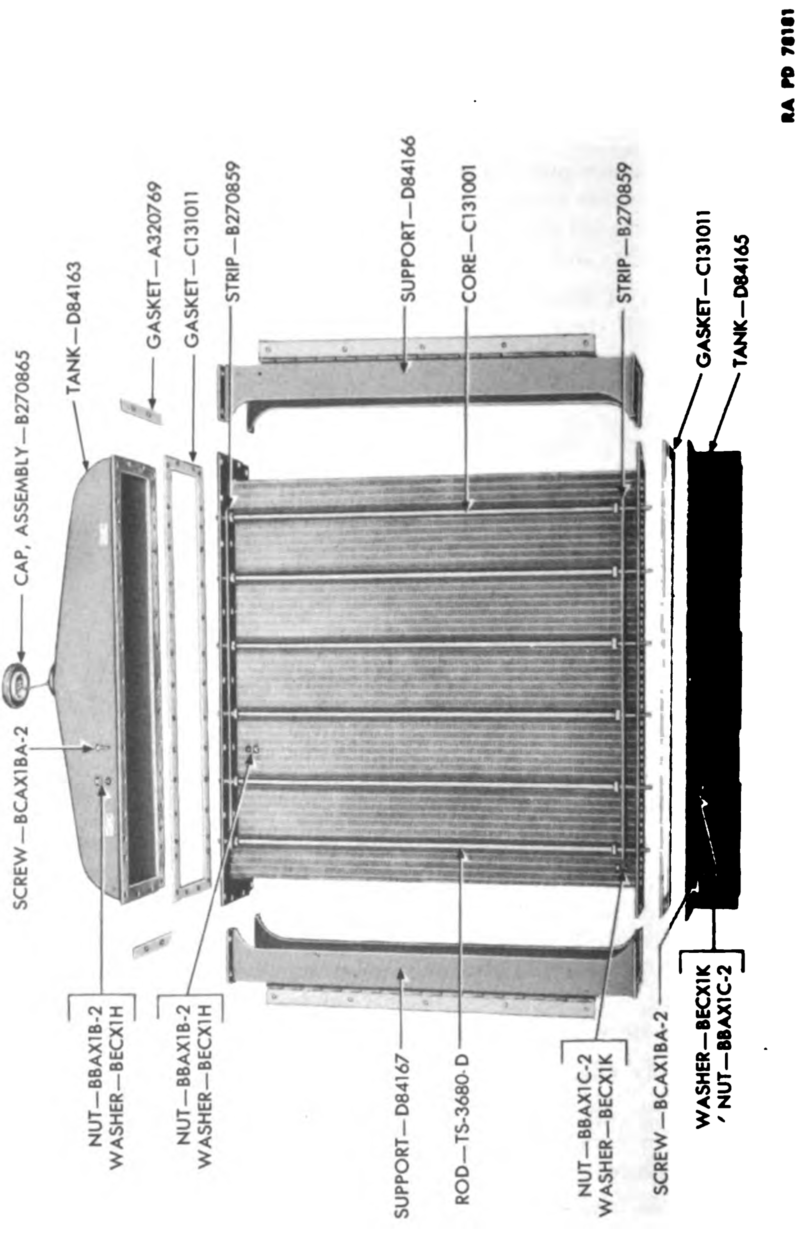


Figure 16—Radiator Disassembled

(3) Using a new gasket, position upper tank on core and side members. Install the 28 screws, lock washers, and nuts which attach tank to core and side members.

(4) Install a lock washer and nut on each end of each of the six steel rods on the front of the assembly.

(5) Position fan shroud on rear of radiator. Install the eight lock washers and shroud to side member screws.

(6) Attach chain to filler cap with screw provided for the purpose. Twist cap onto filler neck.

f. **Installation** (fig. 15).

(1) Position the two pieces of webbing on radiator base support. Place radiator in position on webbing. Screw the two tie rods into their bosses in radiator upper tank. Tighten tie rod lock nuts. Install the four lock nuts and cap screws which anchor radiator to base support.

(2) Using a new gasket, position radiator outlet elbow on radiator lower tank. Install the two lock washers and cap screws which attach elbow to tank. Repeat the procedure to connect radiator inlet elbow to upper tank.

(3) Connect radiator-to-tee hose to overflow tube.

(4) Fill cooling system and run engine to check radiator and connections for leaks. Tighten leaking connections and repair leaks, if any.

(5) Stop engine and install fan guard.

(6) Install radiator doors, hood, all canopy doors and front side panels.

29. FAN.

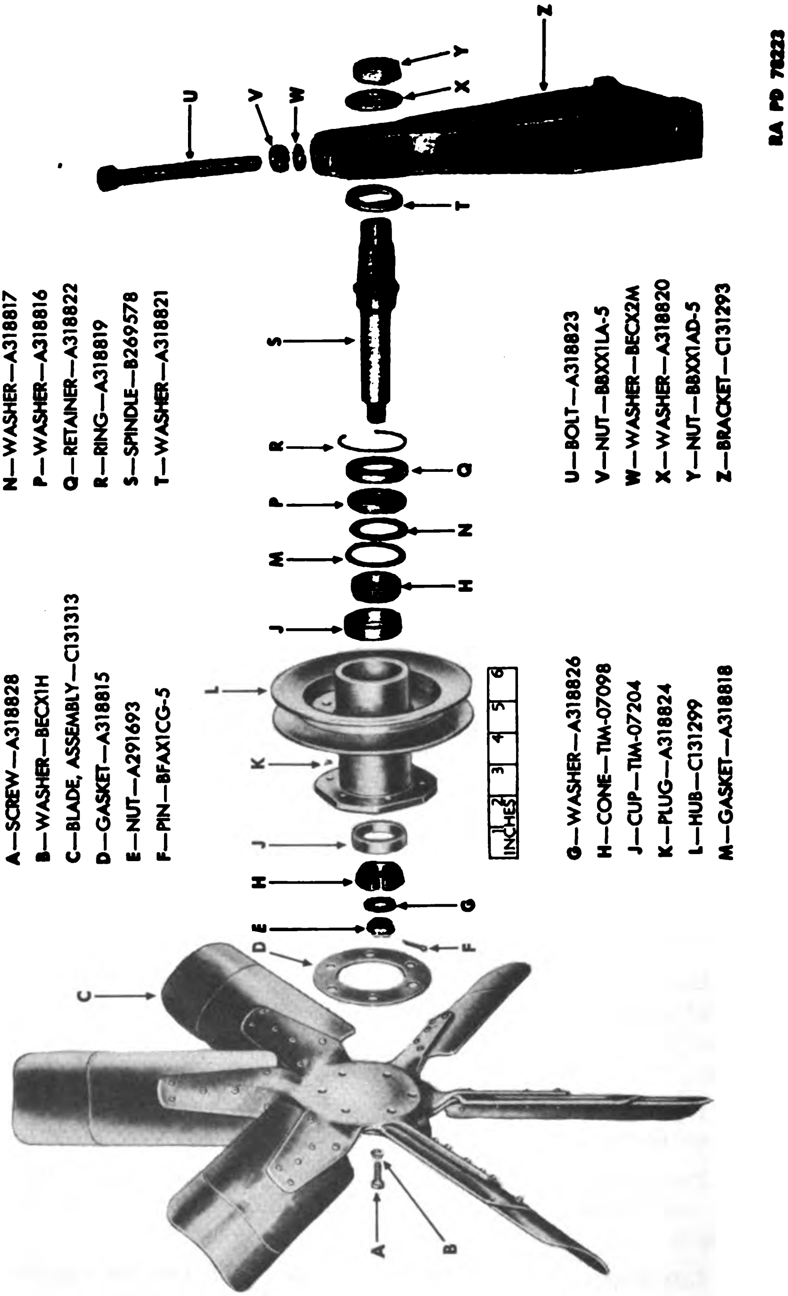
a. **Disassembly** (fig. 17).

(1) Loosen lock nut on fan belt adjusting screw. Unscrew and remove adjusting screw and nut. Remove nut and washer from rear of spindle. Slide spindle from bracket. Slide special washer from rear of spindle.

(2) Remove the six cap screws and lock washers which attach blade assembly to hub. Remove blade assembly and gasket from hub.

(3) Pry snap ring from groove in rear of hub and remove cotter pin, nut, and washer from front end of spindle. Tap spindle from rear of hub.

(4) Lift bearing cone from front of hub. Tap bearing cup from seat at front and at rear of hub (two cups in two seats).



A—SCREW—A318828
B—WASHER—BECX1H
C—BLADE, ASSEMBLY—C131313
D—GASKET—A318815
E—NUT—A291693
F—PIN—BFAX1CG-5

G—WASHER—A318826
H—CONE—TIM-07098
J—CUP—TIM-07204
K—PLUG—A318824
L—HUB—C131299
M—GASKET—A318818

N—WASHER—A318817
P—WASHER—A318816
Q—RETAINER—A318822
R—RING—A318819
S—SPINDLE—B269578
T—WASHER—A318821

U—BOLT—A318823
V—NUT—BBXX1LA-5
W—WASHER—BECX2M
X—WASHER—A318820
Y—NUT—BBXX1AD-5
Z—BRACKET—C131293

Figure 17—Fan Disassembled

(5) Slide retainer, felt washer, steel washer, and gasket from rear of spindle. Press rear bearing from spindle.

b. Inspection.

(1) Clean all metal parts in dry-cleaning solvent, and dry with compressed air. Do not spin bearings or allow air to spin bearings.

(2) Inspect bearings and cups for evidence of scoring, chipping, or loose fit. Test fit of bearings on spindle and cups in hub.

(3) Check spindle threads for burring, or evidence of stripping. If bearing failure was the cause of disassembly, inspect spindle for evidence of scoring at point of contact with bearing race.

(4) Check fan blade assembly for loose rivets or bent blades.

(5) Inspect hub and bracket to see if either is cracked or broken. In case of bearing failure, inspect bearing cup seats for scoring.

(6) Inspect nuts, screws, washers, snap ring, and retainer to see if they are bent or broken. Note condition of threads on threaded parts.

c. Repair. Replace fan assembly if unrepairable.

d. Assembly (fig. 17).

(1) Press front and rear bearing cups to their seats in hub. Pack bearings with general purpose grease (No. 2) and position bearings in cups.

(2) In order named, install gasket, steel washer, felt washer, retainer, and snap ring in recess in rear of hub.

(3) Insert spindle through hub from rear. Install washer and nut on front end of spindle. Tighten nut sufficiently to eliminate side play but not tight enough to interfere with free rotation. Install cotter pin.

(4) Position blade gasket and blade assembly on front of hub. Install the six lock washers and cap screws which attach blade assembly to hub.

(5) Position special washer on rear of spindle and insert rear of spindle into bracket. Install flat washer and nut on rear of spindle. Screw lock nut onto adjusting screw, slide lock washer onto screw, and screw adjusting screw into top of bracket. Do not tighten nut until fan belt adjustment is made after installation.

30. WATER PUMP.

a. Disassembly (fig. 18).

(1) Drive out pin which attaches coupling sprocket to shaft, and press sprocket from shaft.

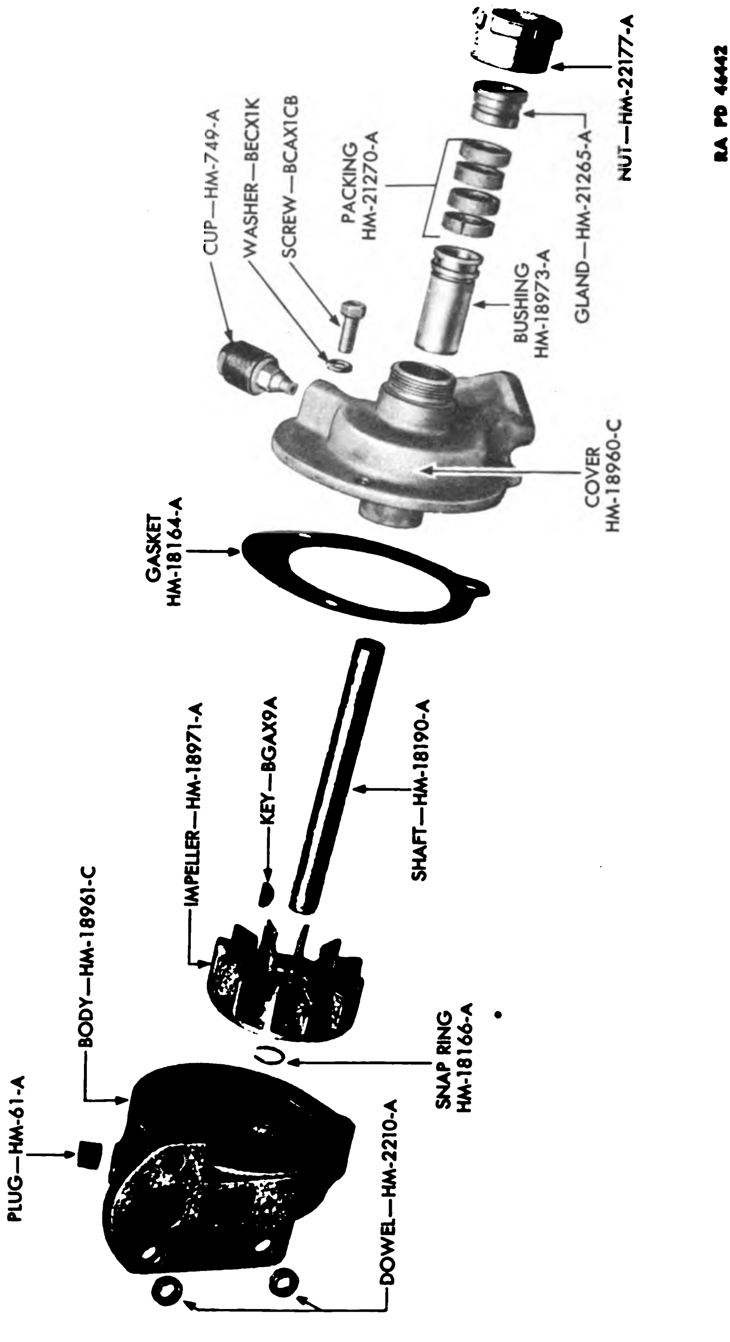


Figure 18—Water Pump Disassembled

(2) Remove the three cap screws and lock washers which attach cover to body. Lift cover and gasket from body. Screw grease cup and packing nut from cover. Remove gland, packing, and impeller back off shaft. Remove key from shaft.

(3) Press impeller down onto shaft and remove snap ring. Press impeller back off shaft. Remove key from shaft.

(4) Tap dowels from base screw holes. Unscrew plug and drain cock from body.

b. Inspection.

(1) Wash all metal parts with dry-cleaning solvent, and dry with compressed air.

(2) Inspect body and cover for cracks.

(3) Test fit of impeller on shaft. It should be a press fit. Inspect impeller to be sure no fins are broken. Examine keyway on shaft to see if it is burred or spread.

(4) Test fit of shaft in bushing. No perceptible side play is permissible. Inspect shaft and bushing to see if either is scored.

(5) Inspect screws, dowels, washers, plug, snap ring, key, and gland to see if any are bent, broken, burred, or if threads (on threaded parts) are damaged.

c. Repair.

(1) Clean burs from all parts with a fine mill file. Clean up damaged threads with a tap or a die.

(2) Replace broken worn, or bent parts. Replace all gaskets and packing. Replace water pump assembly, if unrepairable.

d. Assembly (fig. 18).

(1) Tap key to seat in keyway in shaft. Press impeller onto shaft and key far enough to permit installation of snap ring. Install snap ring on shaft and press impeller back on shaft until it seats against snap ring.

(2) Press shaft bushing in cover to stop. Insert impeller shaft into position through bushing in cover. Install four rings of new packing, the gland, and packing nut.

(3) Position body on cover, using new gasket, and install the three lock washers and cap screws which attach the parts.

(4) Install grease cup in its boss on cover.

(5) Screw plug and drain cock into their respective bosses on body. Tap dowels to seat in base screw holes.

(6) Tap coupling sprocket onto end of shaft with pinholes in sprocket and shaft alined. Drive pin into pinhole and peen pin.

Section III

FUEL SYSTEM

31. DESCRIPTION.

a. **General** (figs. 19 and 20). The fuel system consists of a carburetor, air cleaner, throttle body, governor, fuel pump, gasoline tank, and necessary controls and lines. In operation, the fuel pump draws gasoline from the tank and forces it to the carburetor. At the carburetor the gasoline is mixed with air and converted into vapor. Suction of the engine pistons pulls air through the air cleaner into the carburetor where it picks up the fuel vapor. The same action carries the vapor along through the intake section of the manifold into the engine cylinders.

b. **Air Cleaner** (fig. 19). Abrasive impurities are removed from air entering the carburetor by the air cleaner. The air is drawn through an element of steel wool which is constantly moistened with oil vapor from the cup on the bottom of the cleaner. Dirt in the air adheres to the oil, and settles in the bottom of the cup. Except for the steel wool element, all parts of the air cleaner are made of sheet steel.

c. **Carburetor** (fig. 19). The carburetor is a downdraft type, mounted on top of the manifold. It employs a primary and a secondary vanturi to aid in complete vaporization of the fuel. The carburetor is designed with a vacuum-controlled power jet and accelerating system. These auxiliary jet systems are to provide the extra fuel needed for rapid acceleration.

d. **Throttle Body** (fig. 20). The throttle body is a casting which houses a butterfly valve controlled by the governor. A water jacket is provided in the casting. Heated water from the cooling system flows through the water jacket. This feature is provided to prevent the valve from freezing in any position during extreme cold-weather operation.

e. **Governor** (fig. 20). The governor is of the centrifugal fly ball type. A spring tends to hold the throttle valve in wide-open position. The weight force, opposing the spring, tends to close the valve. The governor spring is located outside the governor case. One end is hooked to the governor lever and the other end is anchored to an adjustable bracket regulated by an adjusting screw. Increasing tension on the governor spring increases engine speed. Inside the governor the weights are hung on a weight spider which is attached to the end of the rotating drive shaft. As the weights revolve, the centrifugal force tends to throw the weights outward. The weights pivot on pins and convert the centrifugal force to a thrust against the sleeve which moves

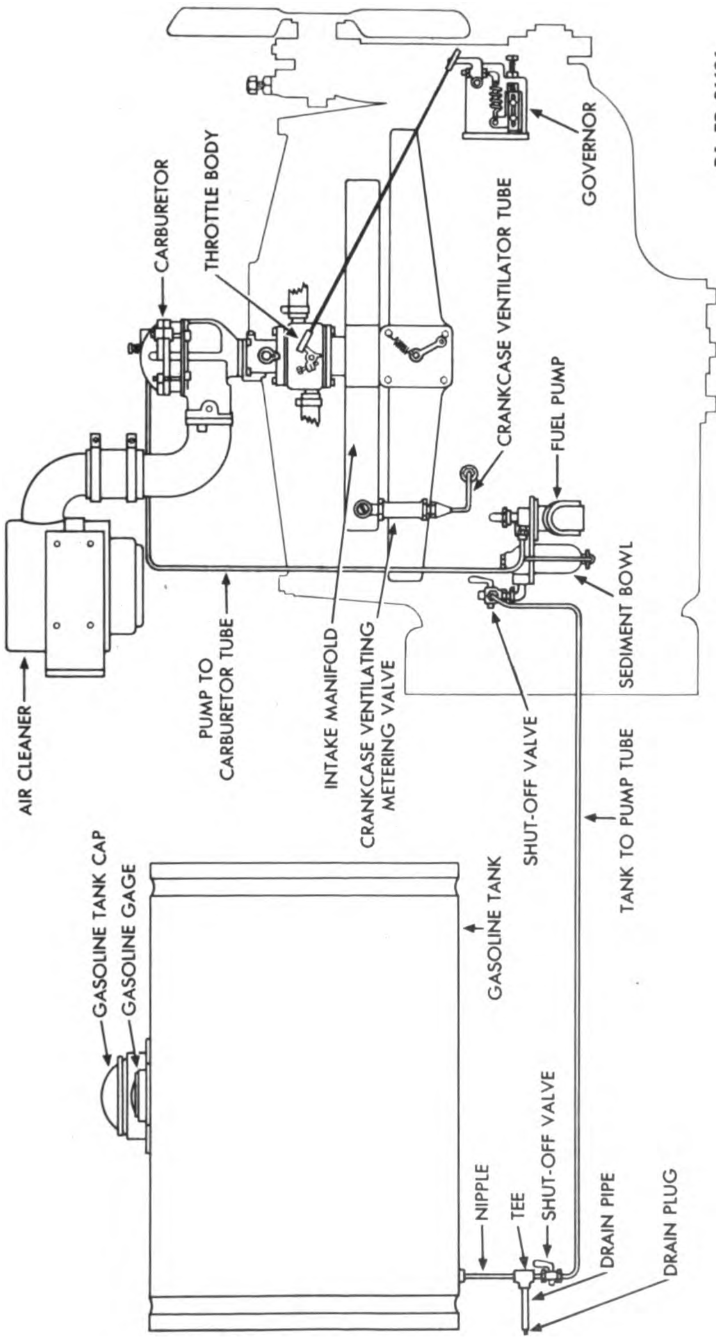


Figure 19—Fuel System Diagram

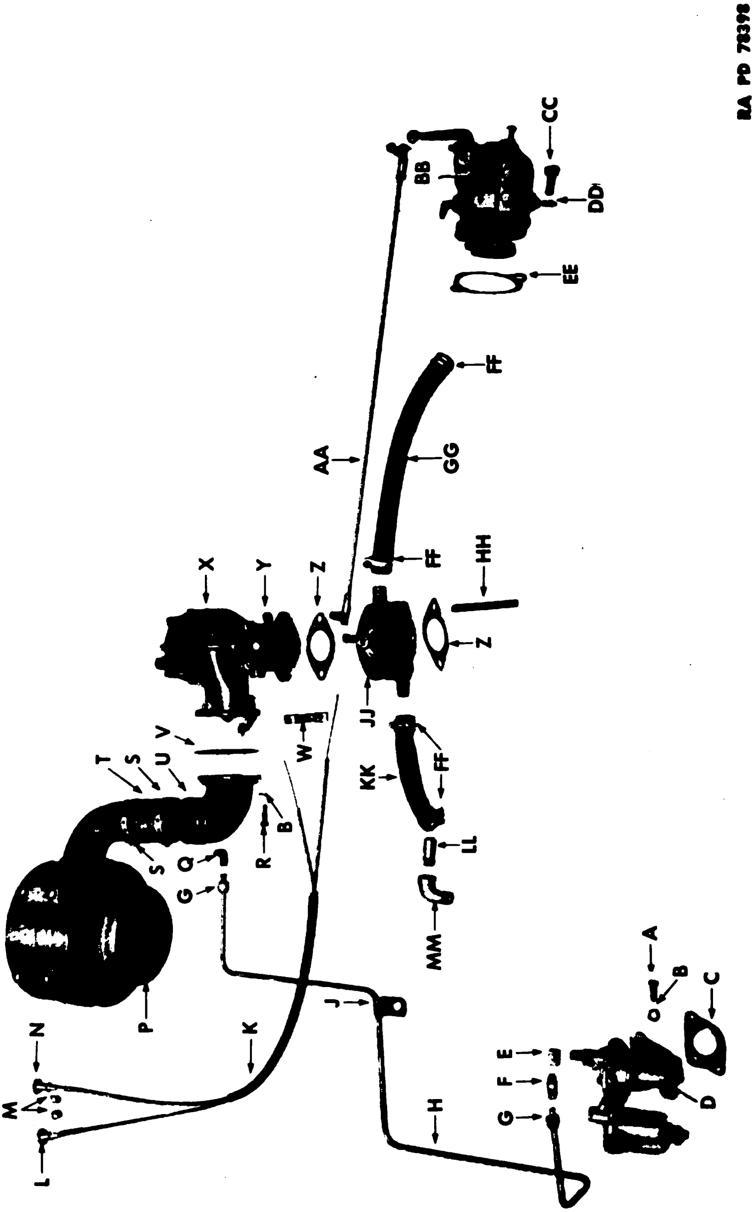
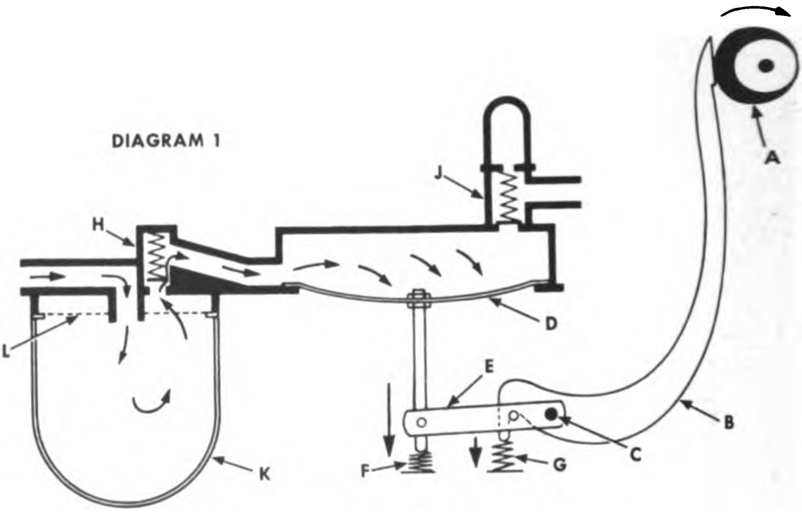


Figure 20—Fuel System Components

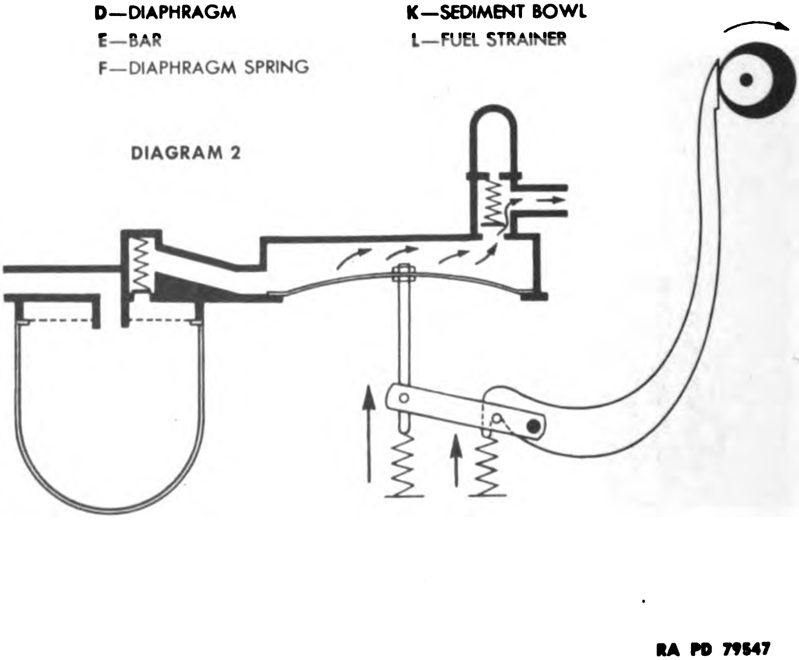
A—SCREW—BCVX2CH-2
B—WASHER—BECX1H
C—GASKET—HM-22564-A
D—PUMP, ASSEMBLY—AC-1537763
E—FITTING—GTS-8157
F—CONNECTOR—CNAX2AD
G—NUT—CNAX5BD
H—TUBE—C132078
J—CLIP—A321660
K—TUBE—A320778
L—CONTROL—B181174
M—NUT—BBSX4AC-2
N—CONTROL—B181175
P—CLEANER, ASSEMBLY—C132077
Q—ELBOW—CNAX3AD
R—SCREW—BCAX1BB-2
S—CLAMP—CMAX1K
T—HOSE, RADIATOR, 2¼ I. D. x 2⅝ O. D. x 3¾ LONG
U—ELBOW—B175951
V—GASKET—A202362
W—CLIP—B270879
X—CARBURETOR, ASSEMBLY—D83533
Y—NUT—BBTX1FB
Z—GASKET—A321664
AA—ROD, ASSEMBLY—KS-26411
BB—GOVERNOR, ASSEMBLY—D83534
CC—SCREW—BCVX2GL-2
DD—WASHER—BECX1L
EE—GASKET—HBC-35J-403
FF—CLAMP—CMAX1D
GG—HOSE, RUBBER, ⅝ I. D. x 1 O. D. x 12½ LONG
HH—STUD, S., ⅜-16NC-3 x 3½ LONG
JJ—BODY, ASSEMBLY—C131383
KK—HOSE, RUBBER, ⅝ I. D. x 1 O. D. x 9 LONG
LL—NIPPLE, PIPE, W. I., ZN-PLTD., STD., ⅜ x 1½, THD. ONE END
MM—ELBOW—CPBX5BC

RA PD 78398A

Legend for Figure 20—Fuel System Components



A—CAM
B—ROCKER ARM
C—ROCKER ARM PIVOT
D—DIAPHRAGM
E—BAR
F—DIAPHRAGM SPRING
G—ROCKER ARM SPRING
H—INTAKE VALVE
J—OUTLET VALVE
K—SEDIMENT BOWL
L—FUEL STRAINER



RA PD 79547

Figure 21—Fuel Pump Action Diagrams

longitudinally on the drive shaft. This movement is transmitted to a rocker shaft by means of a yoke which contacts the thrust bearings on the thrust sleeve. The governor lever attached to this shaft is connected to a butterfly valve in the throttle body by means of a rod. Screw-type ball and socket fittings are used on both ends of the rod. As the speed of the engine reaches the predetermined maximum, the interaction of spring and weights acts to hold the butterfly valve to the proper degree of opening. In this manner, engine speed is controlled. In actual operation, at loads within the rating of the generator, the governor maintains the speed regulation to within plus or minus 3 percent.

f. **Fuel Pump** (figs. 20 and 21). The fuel pump is a mechanical-diaphragm type operated by an eccentric on the engine camshaft. The fuel pump rocker arm is held against the eccentric on the cam by spring action. Action of the eccentric and a diaphragm spring causes the rocker arm to move back and forth. Linkage connects the rocker arm to a rod which in turn is connected to the diaphragm. Thus the motion of the rocker arm is transmitted to the diaphragm, creating a suction and pressure action which draws gasoline from the main fuel tank and forces it to the carburetor. Spring-loaded valves within the pump cover control the direction of the fuel flow.

g. **Gasoline Tank** (fig. 19). The gasoline tank is a welded sheet-steel construction. Bosses at diagonally opposite corners of the bottom of the tank are threaded to receive a fuel line fitting and pipe plug, respectively. The fuel line feeds from the lower right front corner of the tank. A filler cap is provided with a special flame arrester screen. A mechanical-type fuel gage is set into the top of the tank adjacent to the filler neck.

h. **Gasoline Lines and Valves** (fig. 19). Two copper gasoline lines are used. One runs from gasoline tank to fuel pump, the other from fuel pump to carburetor. Flared tube fittings are used. A drain pipe and plug are provided at the fitting where the gasoline line joins the gasoline tank. A shut-off valve is located at each end of the tank-to-pump line.

32. AIR CLEANER.

a. **Disassembly** (fig. 22). Twist oil cup counterclockwise and lift from body. Lift vortex chamber from oil cup. Pull removable pre-filter from under side of body. Remove clamp nut and bolt, and slide bracket from body. Slide the two bracket angles from bracket strap. Do not disassemble further unless necessary to make repairs. When necessary, proceed as follows:

(1) Pinch end of studs together and lift vortex chamber base and three coil springs from studs.

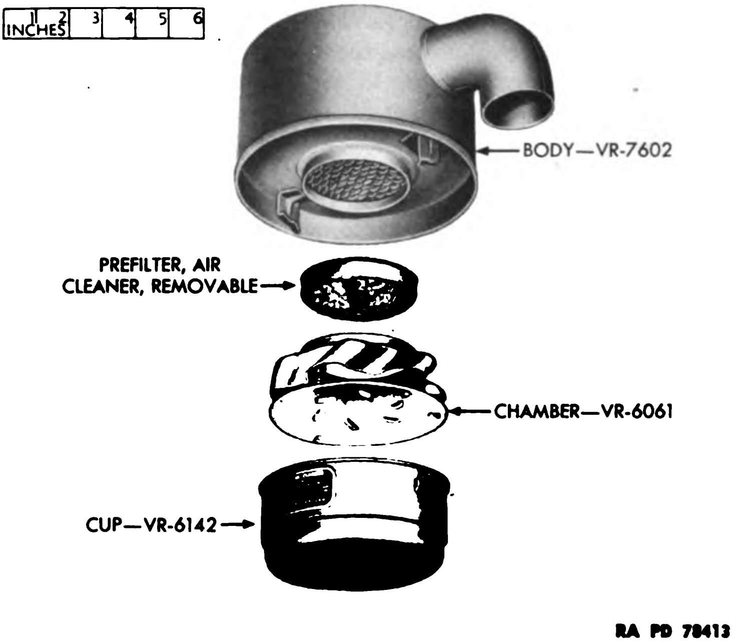


Figure 22—Air Cleaner Disassembled

(2) Straighten the three ears which hold the two parts of the removable prefilter housing together. Separate housing and remove steel wool.

(3) Pull wire screen and steel wool from bottom of body.

b. Inspection and Repair.

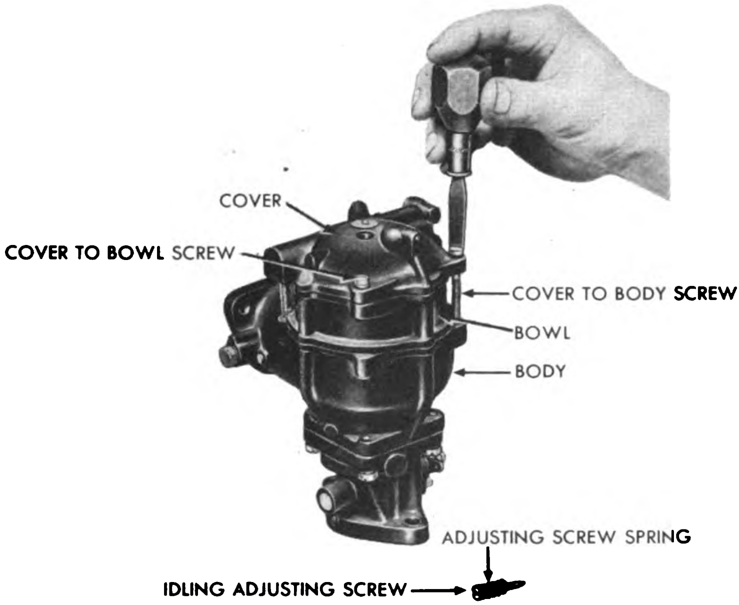
(1) Clean all parts in dry-cleaning solvent, and allow to drain until dry.

(2) Inspect sheet metal parts to see if any are bent or broken. Inspect steel wool to see if it is matted or gummy. Inspect bolts, nuts, and springs to see if any are bent or broken. Examine threads of bolts and nuts to see if any are burred or stripped.

(3) Remove dents from sheet metal parts. Replace all broken parts. Replace matted or gummy steel wool if it cannot be cleaned satisfactorily in solvent. Remove all burs with a file. Replace bolts and nuts which are stripped.

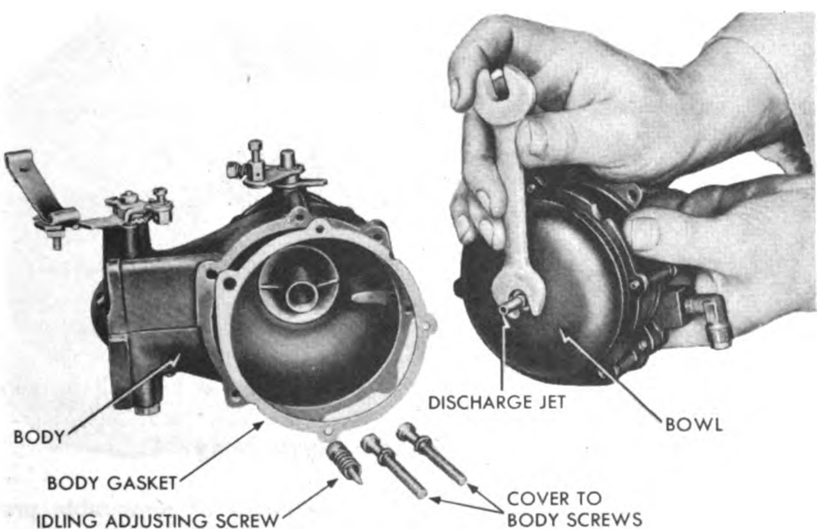
c. Assembly (fig. 22).

(1) Insert steel wool into body and force wire screen across inside of bottom opening.



RA PD 78596

Figure 23—Carburetor Cover-to-body Screw—Removal



RA PD 78611

Figure 24—Discharge Jet Removal

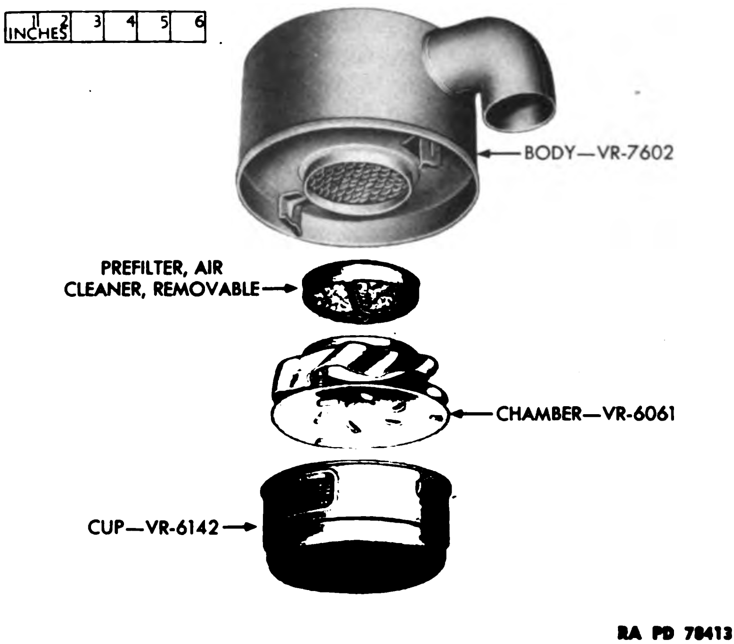


Figure 22—Air Cleaner Disassembled

(2) Straighten the three ears which hold the two parts of the removable prefilter housing together. Separate housing and remove steel wool.

(3) Pull wire screen and steel wool from bottom of body.

b. Inspection and Repair.

(1) Clean all parts in dry-cleaning solvent, and allow to drain until dry.

(2) Inspect sheet metal parts to see if any are bent or broken. Inspect steel wool to see if it is matted or gummy. Inspect bolts, nuts, and springs to see if any are bent or broken. Examine threads of bolts and nuts to see if any are burred or stripped.

(3) Remove dents from sheet metal parts. Replace all broken parts. Replace matted or gummy steel wool if it cannot be cleaned satisfactorily in solvent. Remove all burs with a file. Replace bolts and nuts which are stripped.

c. Assembly (fig. 22).

(1) Insert steel wool into body and force wire screen across inside of bottom opening.

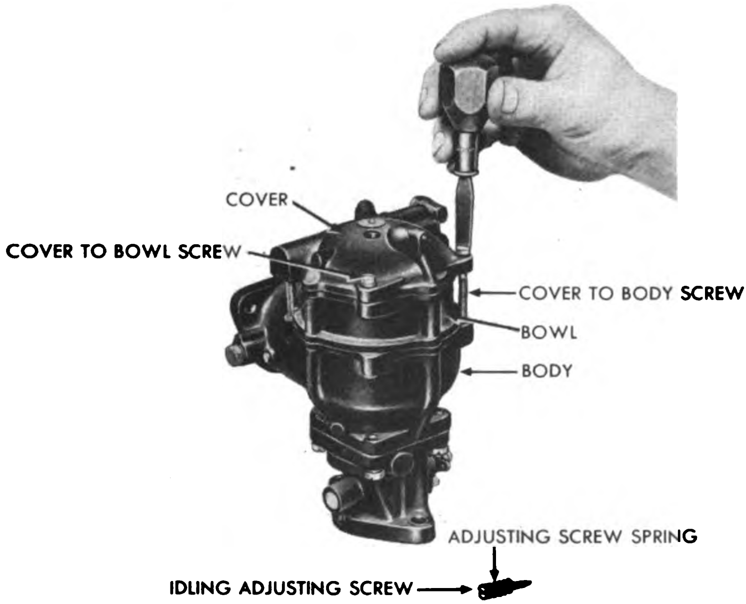


Figure 23—Carburetor Cover-to-body Screw—Removal

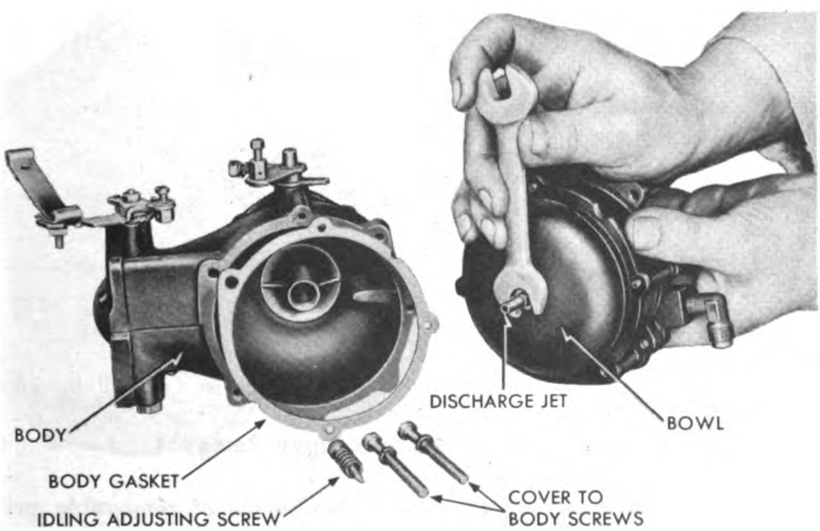


Figure 24—Discharge Jet Removal

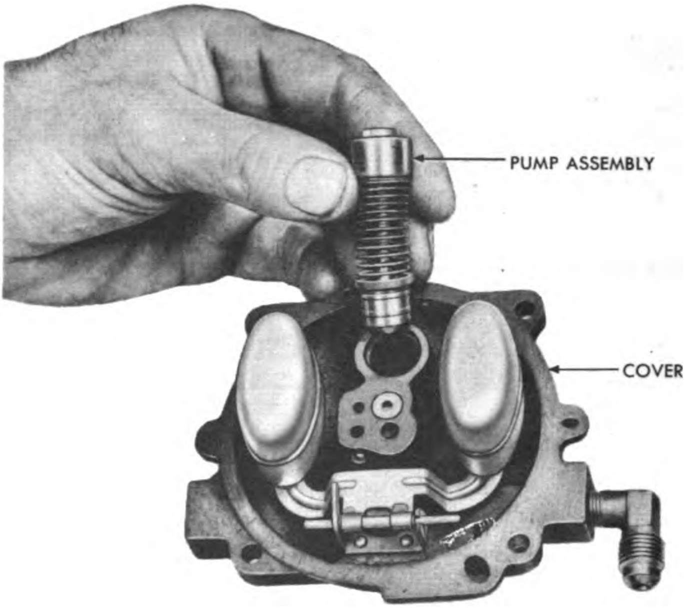


Figure 25—Pump Assembly Removal

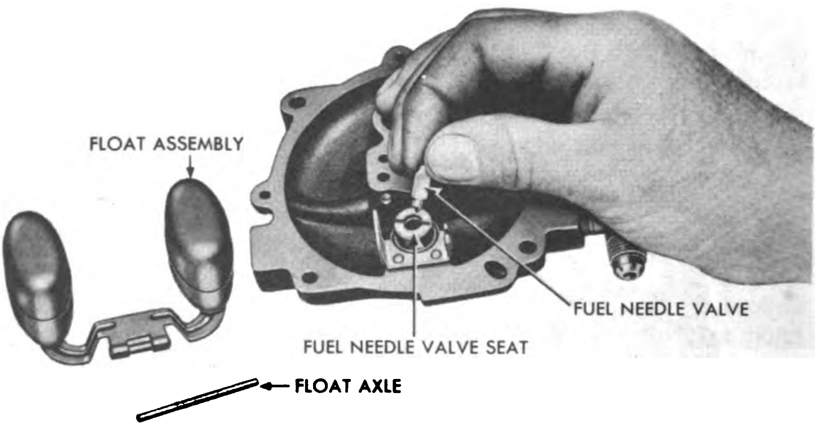


Figure 26—Fuel Needle Valve Removal

(2) Position steel wool between the halves of removable prefilter housing. Force housing together and bend over ears which hold housing together. Push prefilter into position over opening on under side of body.

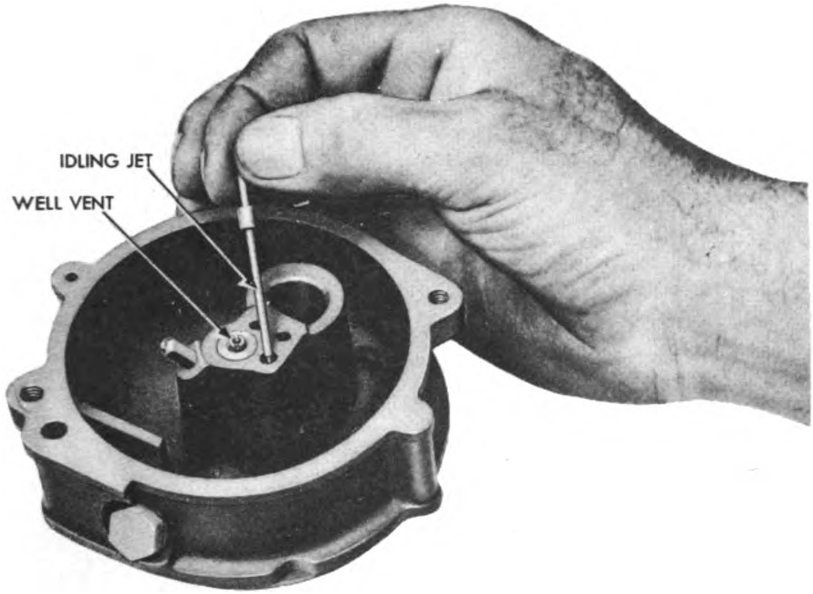


Figure 27—Idling Jet Removal

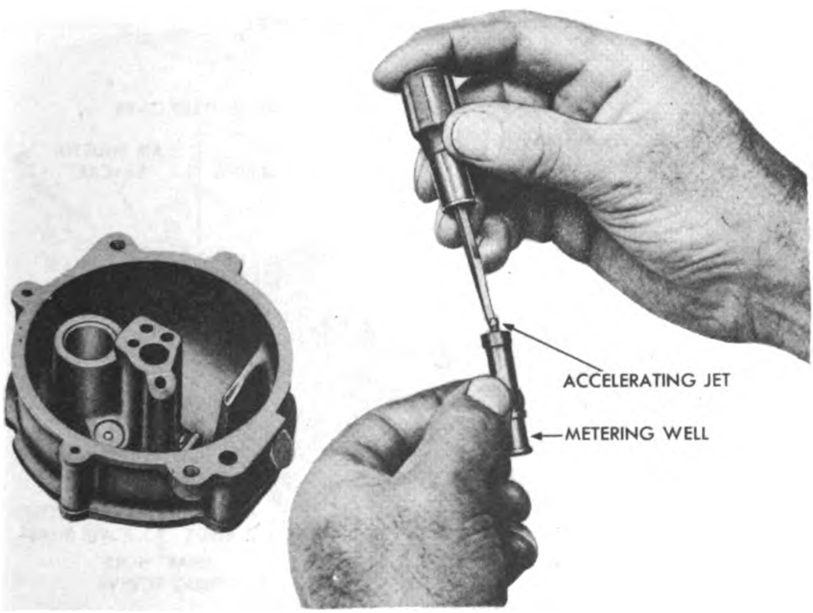


Figure 28—Removing Accelerating Jet From Metering Well

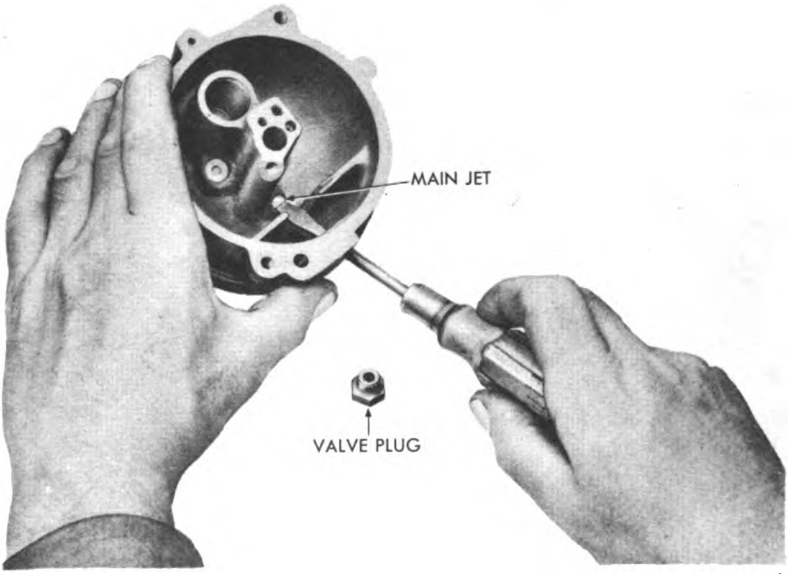


Figure 29—Main Jet Removal

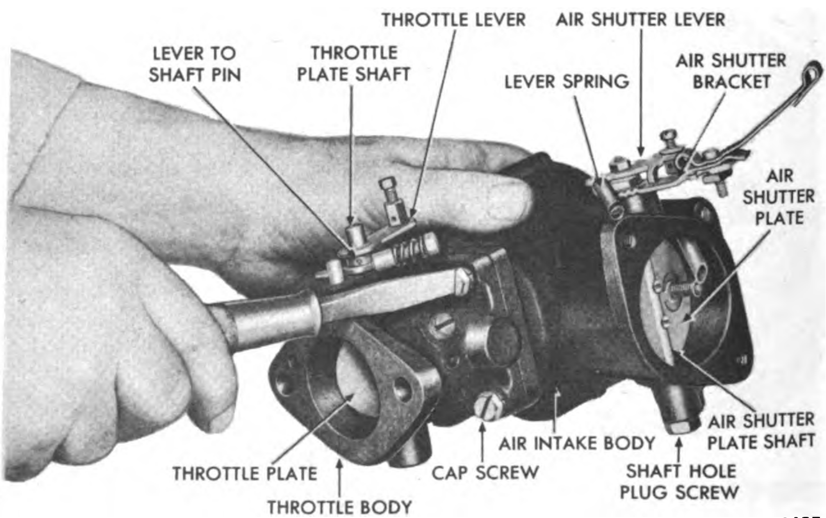


Figure 30—Throttle Body Removal

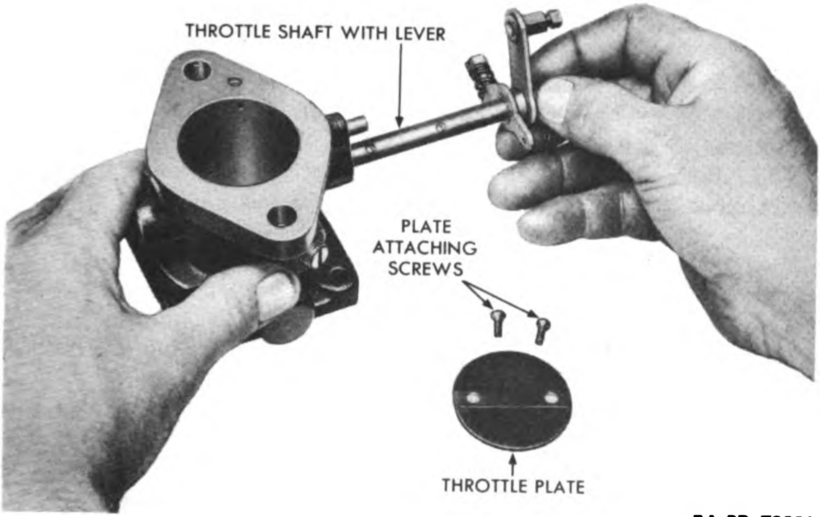


Figure 31—Throttle Shaft With Lever Removal

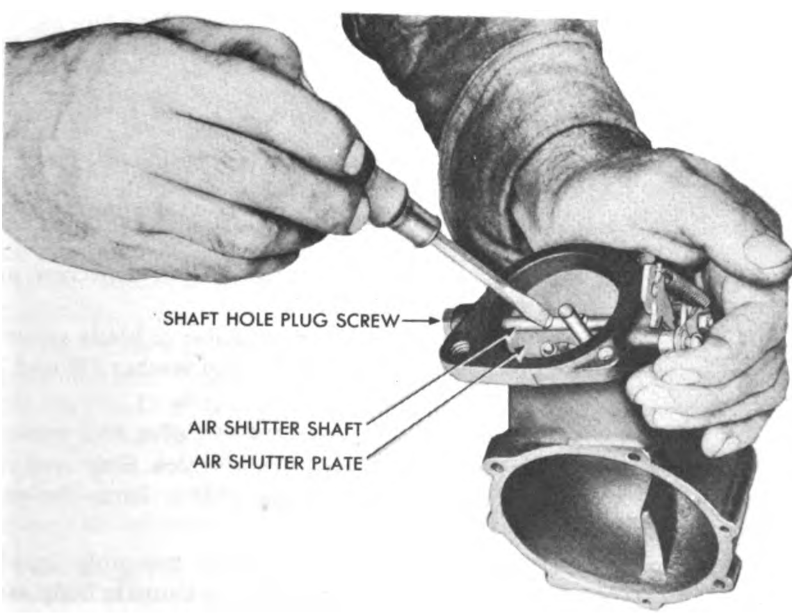


Figure 32—Removing Air Shutter Plate Retainer Screws

(3) Place a coil spring on each stud on vortex chamber cover. Force base onto studs over springs and spread tips of studs. Position vortex chamber, base down, in oil cup.

(4) Position oil cup to bottom of body and twist clockwise until securely engaged. Do not service oil cup with oil until after installation.

(5) Slide bracket angles onto bracket strap. Position bracket strap about body and install clamp bolt and nut.

33. CARBURETOR.

a. Disassembly.

(1) Unscrew idling adjusting screw at top of carburetor. Remove screw and spring (fig. 23).

(2) Take out the two long outside cover-to-body screws and washers which hold the bowl to the air intake body (fig. 23). Remove bowl, turn upside down and take off gasket.

(3) Unscrew discharge jet and remove jet and washer (fig. 24).

(4) Turn the bowl right side up and remove the two short cover-to-bowl screws and washers (fig. 34). Remove cover and gasket from bowl.

(5) Lift pump assembly out of cover (fig. 25).

(6) Push float axle (figs. 25 and 26) through slotted end of the hinge bracket and remove. Take out float assembly and fuel needle valve (fig. 26).

(7) Unscrew fuel needle valve seat (fig. 26), and remove seat and washer.

(8) Lift idling jet out of the bowl casting (fig. 27).

(9) Unscrew well vent (fig. 27) from the bowl casting and remove.

(10) Remove metering well and accelerating jet. Unscrew accelerating jet from metering well (fig. 28).

(11) Carefully center a screwdriver (with center of blade ground out) on valve head and remove power jet valve and washer (R and S, fig. 34).

(12) Unscrew valve plug (fig. 29), and remove plug and washer.

(13) Insert screwdriver through hole from which plug was removed, loosen main jet, and remove jet and washer from the carburetor (fig. 29).

(14) Turn throttle body and air intake body assembly upside down. Remove cap screws and washers connecting throttle body and air intake body (fig. 30). Remove throttle body and gasket. Lift venturi from throttle body.

(15) File off the peened ends of the screws which hold throttle plate in shaft, and remove screws. Slide plate through shaft and remove from shaft. Pull shaft with lever from body (fig. 31).

(16) Drive out pin (fig. 30) which attaches throttle lever to shaft. Slide lever from shaft. Remove the two screws and one coil spring from lever.

(17) Remove lever spring from between air shutter lever and bracket. Remove nut, washer, and lever from shaft. Remove special screw which attaches bracket to body and lift air shutter bracket (fig. 30) from body.

(18) File the peened ends of the air shutter plate retainer screws and remove the screws (fig. 32). Push air shutter plate (fig. 30) through shaft and remove. Slide shaft out of body with lever in position. Take out shaft hole plug screw and remove plug screw and washer (fig. 30).

b. Inspection.

(1) Wash all parts in dry-cleaning solvent, and dry with compressed air.

(2) Inspect bowl body, air intake body, throttle body, and bowl body cover for cracks and fractures. These are iron castings and may break. Blow out all air and jet holes with compressed air. Make certain air and jet holes are unobstructed.

(3) Inspect condition of solder which holds the halves of each float together. Look for cracks or breaks. Shake floats. If a slushing sound is heard, indicating gasoline within the float, the float leaks and must be discarded.

(4) Examine jets, venturi tubes, valve seats, and tubes for cracks, fractures, or possible obstruction due to dirt or other foreign matter.

(5) Examine threads of all screws, plugs, nuts, and connections. Be sure drilled openings are free of dirt and foreign matter. Examine valves, washers, levers, float axle hinge, and hinge bracket for breakage.

(6) Check all jet orifices with proper size drills. Standard drill sizes to check orifices are as follows: discharge jet orifice, drill size No. 26 (40-D-1890-26; main jet orifice, drill size No. 65 (40-D-1319); idling jet orifice, drill size No. 69 (40-D-1890-69); accelerating jet orifice, drill size No. 70 (40-D-1890-70). If worn oversize, replace with new jets. When replacing jets, make sure new jets have the same calibration numbers as the old.

c. Repair.

(1) MAINTENANCE.

(a) Remove, disassemble, and thoroughly clean in dry-cleaning solvent at least once a year or after every 500 hours of operation.

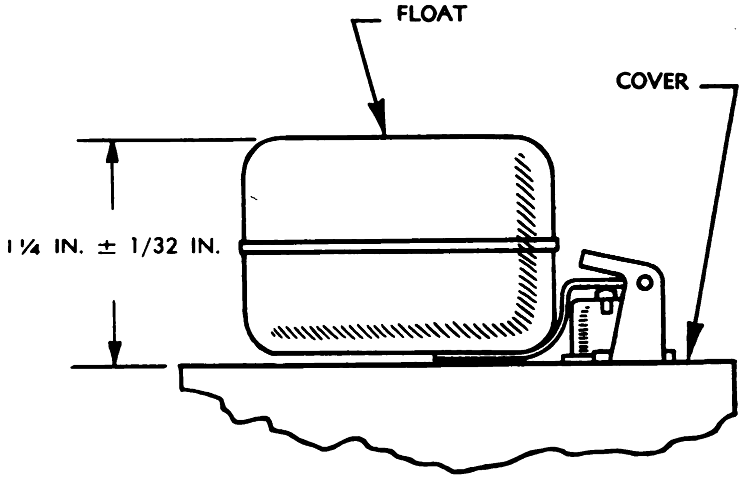


Figure 33—Float Level Dimension

(b) All carburetor adjustments, except idling, are fixed. For this reason the carburetor should give a minimum of trouble, providing regular cleaning and inspection schedules are maintained. However, carburetor jets will wear and result in an over rich mixture, reducing engine efficiency; therefore, it should be disassembled, cleaned, and inspected after 500 hours of operation.

(c) Correct fuel level is particularly important in obtaining greatest fuel economy. To obtain correct fuel level with normal pump pressure, the distance from the bottom of the float to the bottom of the cover should be 1¼ inches, plus or minus $\frac{1}{32}$ inch (fig. 33).

(d) Uniform idling and part-throttle operation are particularly dependent upon the location of the priming plug in relation to the throttle plate. For this reason, throttle plates and bodies cannot be exchanged. When replacing throttle shaft or plate, back off throttle stop screw so that throttle plate can be closed. Hold the throttle in closed position and scribe a line on the inside of the throttle body along the throttle plate. Using the scribed line as a guide, replace throttle shaft on plate. If new plate shows a noticeable variation from old one, select another plate that fits closely to the scribed line.

(2) REPAIR.

(a) Few carburetor components can be repaired. Trouble of any kind except as noted below is cause for replacement of the complete carburetor or the individual part.

(b) If carburetor float leaks, replace or repair it. To repair, dry outer surface and shake float until gasoline is seen leaking from it

as shown by a damp spot on float. Mark location of leak, and puncture top of float with a sharp pointed tool. Drain gasoline from float through punctured hole. Solder leak and drain hole with a soldering copper. Do not use excessive solder as its weight would keep float from working properly.

(c) To insure correct fuel level with normal pump pressure, set the floats so that distance from the bottom of the floats to bottom surface of the cover is 1¼ inches, plus or minus $\frac{1}{32}$ inch, by bending the float arm (fig. 33).

d. **Assembly** (fig. 34).

(1) Push throttle shaft into throttle body. Insert throttle plate through shaft slot. When throttle plate is properly centered, install new screws to hold it in place. Peen over ends of screws, being careful not to spring shaft. Slide throttle lever onto shaft with pinholes in lever hub and shim alined. Be sure lever points up. Drive pin into pinhole. Slide spring onto stop screw and install the screw into its boss on lever hub. Screw throttle control attaching screw into boss on end of lever.

(2) Position air shutter bracket on air intake body and install the special screw which attaches it to body. Slide air shutter shaft, lever attached (with washer and nut), in place. Insert shutter through shaft slot with relief valve spring up. Install new holding screws. Peen over ends of screws, being careful not to spring shaft. Install spring between bracket and lever.

(3) Using a gasket, screw hexagonal-head shaft hole plug screw in place over end of shaft opposite lever.

(4) Place venturi in throttle body. Install gasket, carefully setting it in proper position so that locating pin extends through gasket and the plate holes are not closed off. Place air intake body in position on throttle body, checking passages and locating pin. Turn upside down and install assembly washers and screws. Tighten screws evenly and securely.

(5) Screw well vent into position in bowl.

(6) Install main jet, with washer, through bowl plug hole. Install bowl plug and new washer.

(7) Install power jet valve and new washer. Have screwdriver properly centered on valve head.

(8) Install accelerating jet in the metering well, using a small screwdriver, while holding the meter well in the hand only.

(9) Install metering well and accelerating jet in the well channel in bowl. Metering well is designed to extend not more than 0.005 inch above the bowl casting to insure a good fit at that point when gasket and cover are in place. Screw vent well down in place.

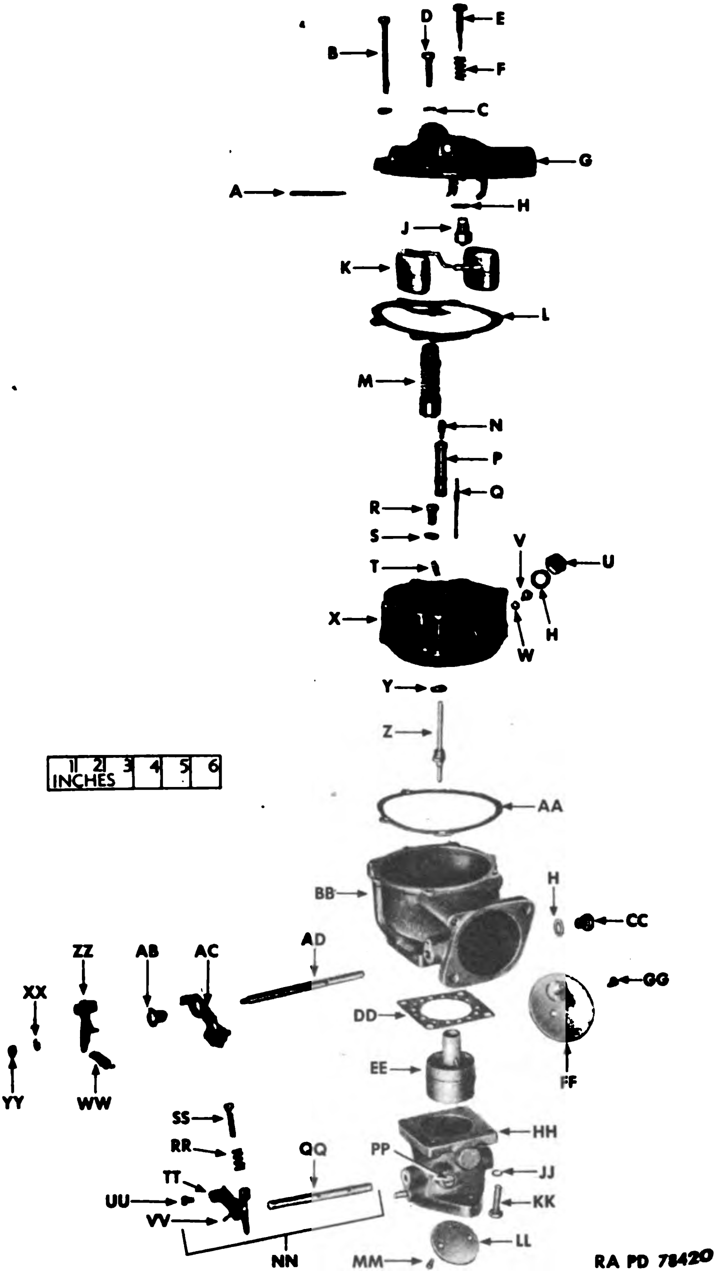


Figure 34—Carburetor Disassembled

ENGINE AND ACCESSORIES

A—AXLE—Z-C120-31
B—SCREW—BCFX2CR-1
C—WASHER—BECX1F
D—SCREW—BCFX2CH-1
E—SCREW—Z-C46-47
F—SPRING—Z-C111-17
G—COVER, ASSEMBLY—Z-B6-13
H—WASHER—Z-T56-23
J—VALVE—Z-C81-1-45
K—FLOAT—Z-C85-79
L—GASKET—A277250
M—PUMP—Z-C36-29X3
N—JET—Z-C55-19-14
P—WELL—Z-C76-27-2
Q—JET—Z-C54-22-15
R—VALVE—Z-C97-22-(17-15)
S—WASHER—Z-T56-14
T—JET—Z-C77-23-18
U—PLUG—Z-C138-23
V—JET—Z-C52-7-25
W—WASHER—Z-T56-24
X—BOWL, ASSEMBLY—Z-B3-89
Y—WASHER—Z-T56-20
Z—JET—Z-C66-57-80
AA—GASKET—A277240
BB—BODY—Z-B4-27
CC—SCREW—Z-C138-24
DD—GASKET—Z-C142-48
EE—VENTURI—Z-C38-57-29
FF—PLATE—Z-C101-41
GG—SCREW—Z-C136-3
HH—BODY, ASSEMBLY—Z-B2-149-2
JJ—WASHER—BECX3G
KK—SCREW—Z-T18S25-14
LL—PLATE—Z-C21-141
MM—SCREW—Z-C136-15
NN—SHAFT, ASSEMBLY—Z-C29-401
PP—PLUG—Z-CT91-3
QQ—SHAFT—Z-C23-360
RR—SPRING—Z-C111-62
SS—SCREW—Z-T8S10-15
TT—LEVER—Z-CR27-153
UU—SCREW—Z-T8S8-7
VV—PIN—BFCX1BA
WW—SPRING—Z-C112-6
XX—WASHER—BEAX1E
YY—NUT—BBMX1B-1
ZZ—LEVER, ASSEMBLY—Z-C106-2
AB—SCREW—Z-C140-7
AC—BRACKET, ASSEMBLY—Z-C109-2
AD—SHAFT—Z-C105-166

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Legend for Figure 34—Carburetor Disassembled

(10) Set idling jet in place in bowl.

(11) Screw fuel valve seat and washer into place in bowl cover. Insert needle into seat.

(12) Place the float arm in position in float hinge bracket and secure with wire pin float axle. The float should move freely on the axle. Hold the float level upside down to observe relation of float to cover. If necessary, bend float arm to secure correct dimension (subpar. c (2) *(c)*, above).

(13) Position pump in bowl cover. If disassembled, assemble pump as follows: place piston rod and piston head in chamber and secure in place with retainer plate; slide sleeve and small spring over piston; insert large spring in the retainer plate flange; attach brass pump head.

(14) Place bowl-to-cover gasket in position on bowl. Hold cover assembly over bowl and guide vacuum piston into vacuum cylinder, and idling jet into its channel. Use care to avoid damage to float and other parts.

(15) Install cover to bowl assembly screws and lock washers, tightening them evenly and securely.

(16) Screw discharge jet (with washer) into place in lower side of bowl.

(17) Place bowl to air intake body gasket in position on bowl. Place bowl assembly with gasket on the air intake body. Be sure channel bushings enter their respective channels. Install the assembly lock washers and screws, tightening them evenly and securely.

(18) Place spring over idling adjusting screw and install screw in tapered hole in cover.

34. THROTTLE BODY.

a. Disassembly (fig. 35).

(1) Punch-prick throttle lever and throttle plate shaft at adjacent points, to facilitate correct assembly.

(2) Remove the two screws and washers which secure throttle plate to shaft. Pull plate from shaft.

(3) Pull shaft with attached lever, three flat washers, and two leather washers from body. Do not lose needle bearings which will fall from body as shaft is removed. Slide washers from shaft.

(4) Pry bearing cup from body and tap out disk washer (plug). Lift brass washer from bushing.

(5) Pull bushings from shaft bosses only if replacement is necessary. Do not pull bushings from attaching stud holes.

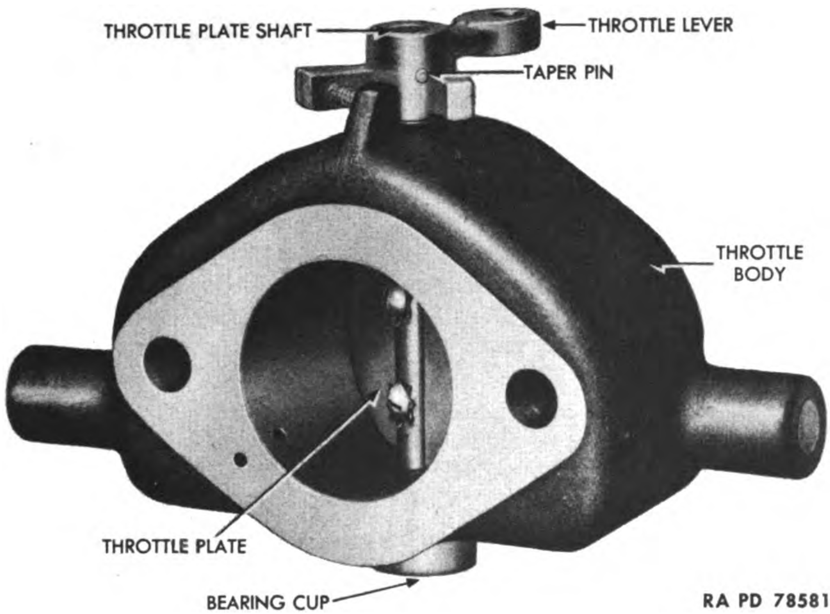

Figure 35—Throttle Body Assembled

(6) Drive out taper pin which attaches lever to shaft, and tap lever from shaft.

b. Inspection.

(1) Clean all metal parts in dry-cleaning solvent, and dry with a cloth.

(2) Inspect body to see if it is cracked. Rust marks are an indication of a fracture permitting leakage.

(3) Inspect shaft and bushings to see if they are scored.

(4) Inspect bearing rollers to see if any are chipped, broken, or noticeably worn.

(5) Inspect metal washers, lever, pin screws, and cap to see if any are bent or broken.

(6) Examine leather washers to see if they are crushed or torn.

(7) Note condition of threads on screws and tapped holes.

c. Repair.

(1) Remove all burs with a fine mill file.

(2) Remove light score marks from shaft with crocus cloth.

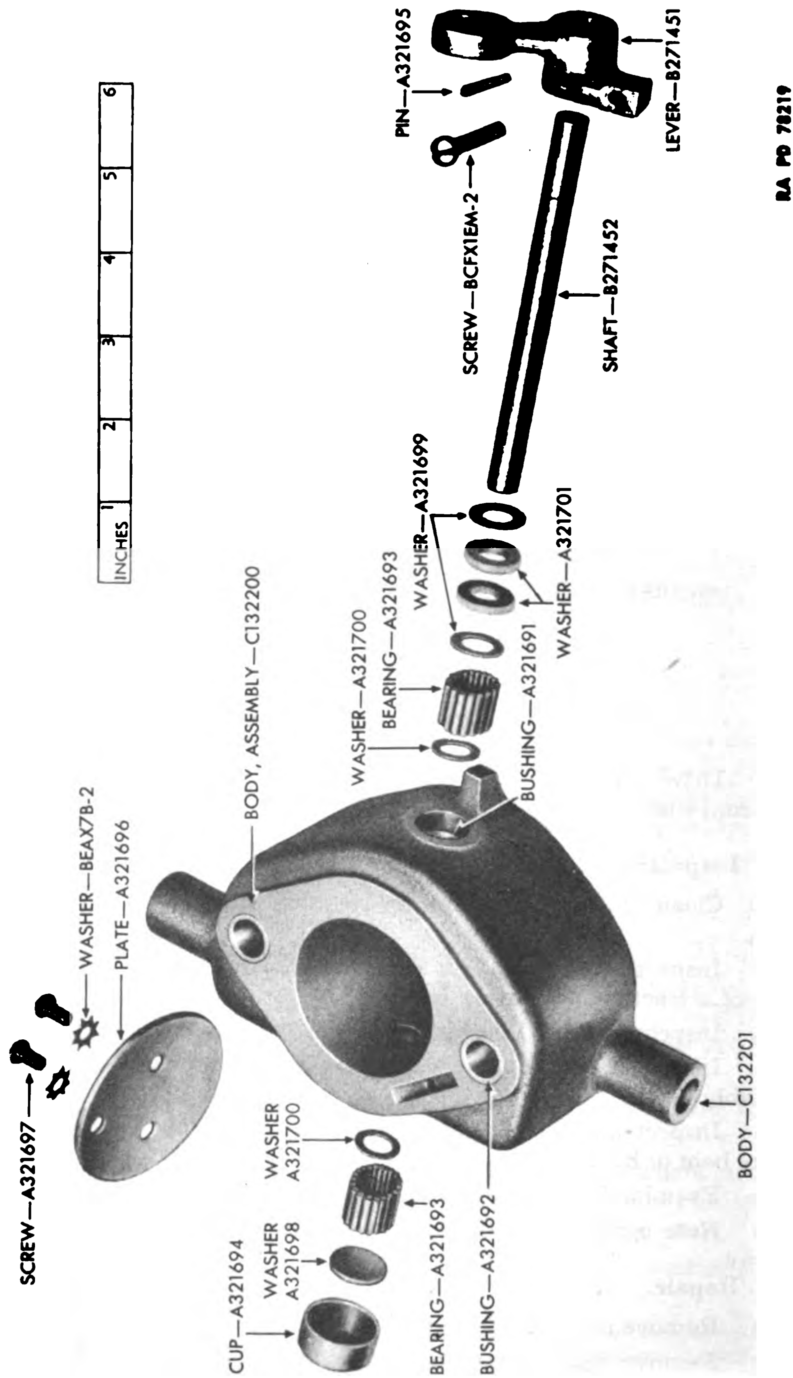

Figure 36—Throttle Body Disassembled

d. **Assembly** (fig. 36).

(1) If old shaft bushings were removed, press new bushings into shaft bosses on body. Ream bushing to secure 0.002-inch shaft clearance. If using a new shaft, ream bushing to 0.4945-inch inside diameter.

(2) Insert small diameter brass washer into body through each shaft bushing in body. Stick the 14 needles (which make up shaft bearing) in position within each bushing. Use general purpose grease (No. 0) to hold needles in position.

(3) Slide lever onto shaft so that punch-prick marks are alined. If marks were not made at time of disassembly, carefully measure taper pinholes in lever hub and in shaft. Aline larger lever hub pinhole with larger end of shaft pinhole. Tap taper pin to seat through lever hub and shaft.

(4) On shaft, slide large brass washer, two leather washers, and remaining large brass washer. Insert shaft through bearings in body from side having small shaft boss. Use care to keep from dislodging bearing rollers.

(5) Insert plate through slot in center of shaft. Install the two washers and screws which attach plate to shaft.

(6) Tap disk washer (plug) to seat over end of shaft in large shaft boss. Tap cup to seat over boss.

35. GOVERNOR.

a. **Disassembly.**

NOTE: *Key letters indicated in the disassembly and assembly procedure pertain to figure 40.*

(1) Pry snap ring from end of shaft. Press helical gear from shaft. Tap Woodruff key from shaft.

(2) Remove the two special screws which attach spring guide to body (fig. 37). Unhook extension spring from special eyebolt and lift guide and spring from body.

(3) Loosen lock nut and remove spring guide adjusting screw and lock nut.

(4) Remove oil level plug from front of body, elbow fitting (fig. 37) from top of body, drain plug from bottom of body, and screw with copper gasket from front of body.

(5) Drive taper pin from lever hub and lever shaft. Pull lever from shaft. Remove the nut from special eyebolt and lift eyebolt from lever.

(6) Remove the six machine screws and lock washers which attach flange (fig. 37) to body. Tap flange to break it loose from body and remove with bearing and gasket. Tap bearing from flange.

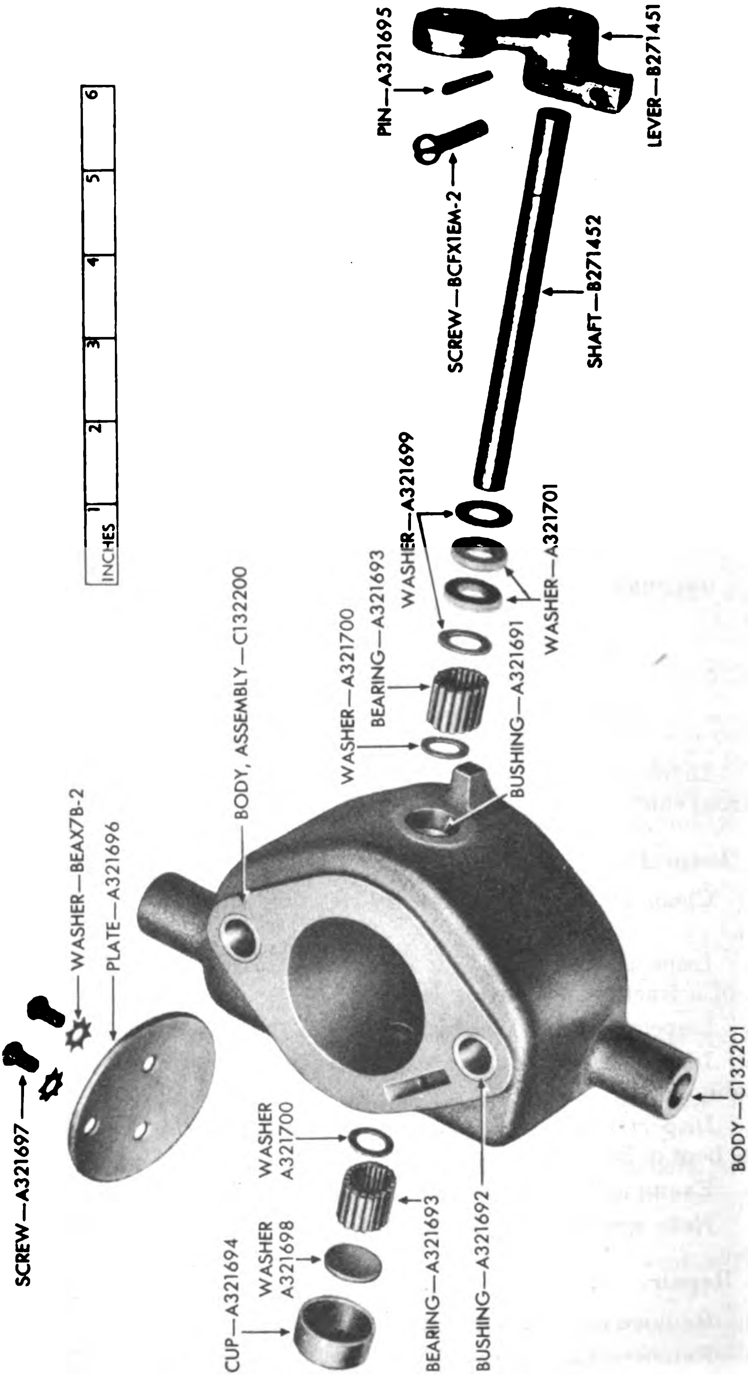

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Figure 36—Throttle Body Disassembled

d. Assembly (fig. 36).

(1) If old shaft bushings were removed, press new bushings into shaft bosses on body. Ream bushing to secure 0.002-inch shaft clearance. If using a new shaft, ream bushing to 0.4945-inch inside diameter.

(2) Insert small diameter brass washer into body through each shaft bushing in body. Stick the 14 needles (which make up shaft bearing) in position within each bushing. Use general purpose grease (No. 0) to hold needles in position.

(3) Slide lever onto shaft so that punch-prick marks are alined. If marks were not made at time of disassembly, carefully measure taper pinholes in lever hub and in shaft. Aline larger lever hub pinhole with larger end of shaft pinhole. Tap taper pin to seat through lever hub and shaft.

(4) On shaft, slide large brass washer, two leather washers, and remaining large brass washer. Insert shaft through bearings in body from side having small shaft boss. Use care to keep from dislodging bearing rollers.

(5) Insert plate through slot in center of shaft. Install the two washers and screws which attach plate to shaft.

(6) Tap disk washer (plug) to seat over end of shaft in large shaft boss. Tap cup to seat over boss.

35. GOVERNOR.

a. Disassembly.

NOTE: *Key letters indicated in the disassembly and assembly procedure pertain to figure 40.*

(1) Pry snap ring from end of shaft. Press helical gear from shaft. Tap Woodruff key from shaft.

(2) Remove the two special screws which attach spring guide to body (fig. 37). Unhook extension spring from special eyebolt and lift guide and spring from body.

(3) Loosen lock nut and remove spring guide adjusting screw and lock nut.

(4) Remove oil level plug from front of body, elbow fitting (fig. 37) from top of body, drain plug from bottom of body, and screw with copper gasket from front of body.

(5) Drive taper pin from lever hub and lever shaft. Pull lever from shaft. Remove the nut from special eyebolt and lift eyebolt from lever.

(6) Remove the six machine screws and lock washers which attach flange (fig. 37) to body. Tap flange to break it loose from body and remove with bearing and gasket. Tap bearing from flange.

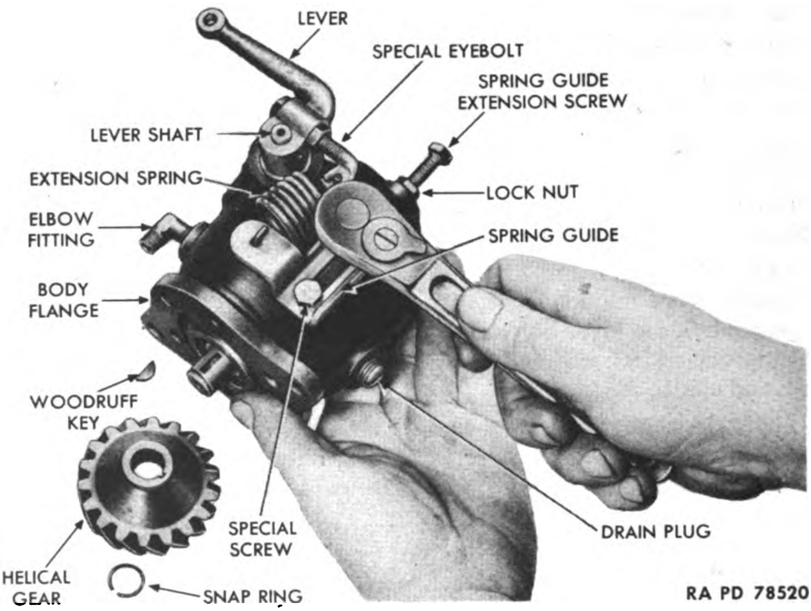


Figure 37—Governor Disassembly (1)

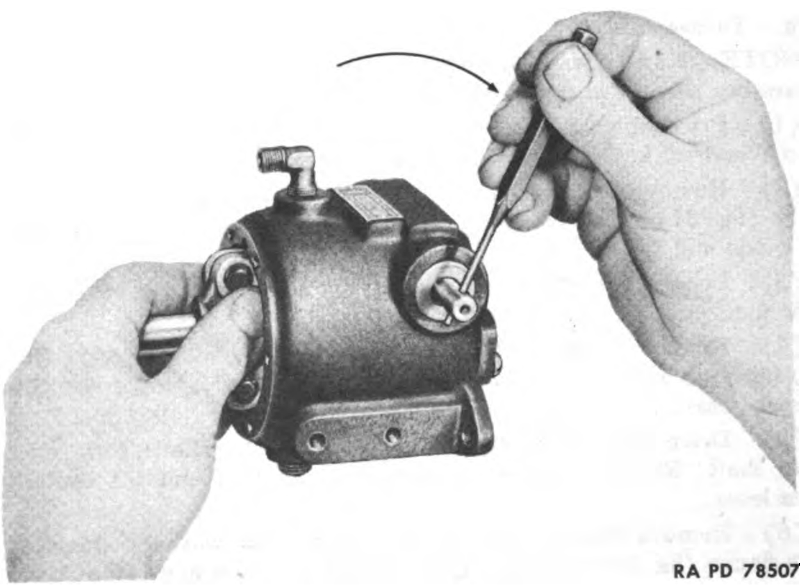


Figure 38—Governor Disassembly (2)

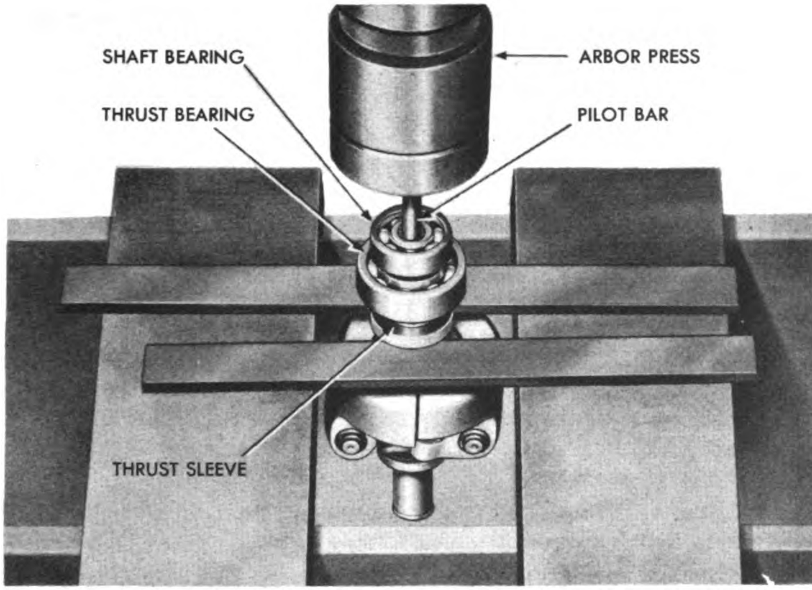


Figure 39—Pressing Bearing From Governor Shaft

(7) Insert a punch through pinhole in lever shaft and twist shaft clockwise (using punch as lever) to free weight shaft assembly (fig. 38). Lift shaft assembly from governor.

(8) Pull hairpin-type clip (V) from fork shaft and pull fork (U) and spring washer (X) from lever shaft (Z).

(9) Tap on protruding end of lever shaft (Z) to remove retainer (BB) from body on other end of shaft. Slide shaft, with one bearing, from body. Tap oil seal (PP) and remaining bearing (NN) from body (fig. 40).

(10) Pry snap ring (AA) from lever shaft (Z) and slide washer (CC) and bearing (DD) from shaft.

(11) Press shaft bearing (T) from front end of shaft, using an arbor press (fig. 39). Place blocks under thrust sleeve flange and place pilot bar to end of shaft. Slide thrust bearing (S) and thrust sleeve (R) from shaft after shaft bearing is removed.

(12) Remove hairpin-type clips (N) from each end of both weight pins (M). Press pins from weights (K) and shaft trunnions. Do not lose the two thin steel washers (J) which are freed upon removal of each pin from weight.

(13) Press weight bearings (P) from weights (two bearings in each of the two weights).

(14) Tap thrust surface stud (L) from each weight.

b. **Inspection.**

(1) Clean all metal parts in dry-cleaning solvent, and dry with compressed air. Do not allow air to spin bearings.

(2) Examine all bearings carefully to see if races and balls or rollers are chipped, burred, nicked, scored, or badly worn. Rotate bearings (do not spin) and listen for grinding noise which indicates defect.

(3) Inspect shaft, thrust sleeve, thrust surface studs on weights, fork, weight axles, and lever shaft to see if any are scored or burred.

(4) Examine flange and body castings to see if either is broken or cracked. Look for burs on machined surfaces. Examine threads in tapped holes to see if any are burred or stripped.

(5) Inspect spring, snap rings, and hairpin-type clips to see if any are broken, bent, or sprung.

(6) Inspect spring guide, plugs, elbows, cup, nuts, weights, washers, and screws to see if any are broken or bent. Observe condition of threads on threaded parts.

(7) Examine oil seal to see if metal is bent or if leather is worn or torn.

c. **Repair.**

(1) Remove burs from machined parts with a fine mill file. Dress slightly scored surfaces with crocus cloth. Replace governor assembly if unrepairable.

(2) Clean up burred or slightly damaged threaded parts with a tap or a die. Replace parts having stripped threads.

(3) Replace oil seal unless it appears to be in new condition. Replace all gaskets.

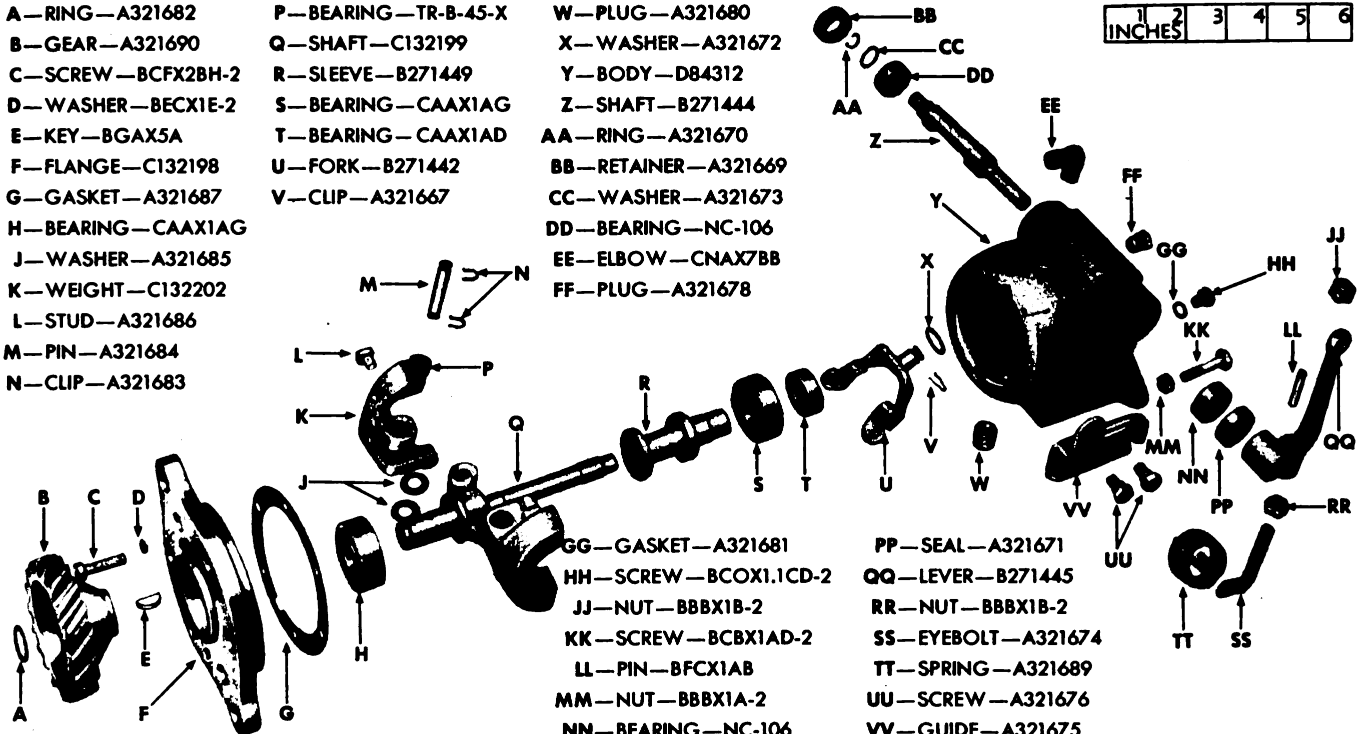
d. **Adjustment.**

(1) After governor has been assembled, install it on the generating unit engine.

(2) Loosen lock nut on adjusting screw and two special screws which attach spring guide.

(3) Turn adjusting nut until engine turns at 1,200 revolutions per minute (indicated by 60-cycle reading on frequency meter of Generating Unit M18). Increasing spring tension increases engine speed.

(4) Tighten lock nut on adjusting screw. Tighten special screws which attach spring guide to body.



A—RING—A321682
B—GEAR—A321690
C—SCREW—BCFX2BH-2
D—WASHER—BECX1E-2
E—KEY—BGAX5A
F—FLANGE—C132198
G—GASKET—A321687
H—BEARING—CAAX1AG
J—WASHER—A321685
K—WEIGHT—C132202
L—STUD—A321686
M—PIN—A321684
N—CLIP—A321683

P—BEARING—TR-B-45-X
Q—SHAFT—C132199
R—SLEEVE—B271449
S—BEARING—CAAX1AG
T—BEARING—CAAX1AD
U—FORK—B271442
V—CLIP—A321667

W—PLUG—A321680
X—WASHER—A321672
Y—BODY—D84312
Z—SHAFT—B271444
AA—RING—A321670
BB—RETAINER—A321669
CC—WASHER—A321673
DD—BEARING—NC-106
EE—ELBOW—CNAX7BB
FF—PLUG—A321678

GG—GASKET—A321681
HH—SCREW—BCOX1.1CD-2
JJ—NUT—BBBX1B-2
KK—SCREW—BCBX1AD-2
LL—PIN—BFCX1AB
MM—NUT—BBBX1A-2
NN—BEARING—NC-106

PP—SEAL—A321671
QQ—LEVER—B271445
RR—NUT—BBBX1B-2
SS—EYEBOLT—A321674
TT—SPRING—A321689
UU—SCREW—A321676
VV—GUIDE—A321675

Figure 40—Governor Disassembled

e. **Assembly (fig. 40).**

(1) Tap thrust surface stud (L) into position in each weight. Press the two bearings (P) into each weight (K) so outer ends of bearings are flush.

(2) Position one weight assembly between trunnions on shaft (Q). Insert steel washer (J) on each side of weight. Press weight pin (M) through openings in shaft trunnions, both washers, and weight bearings. Snap hairpin-type clip (N) onto each end of installed weight pin. Repeat procedure to assemble other weight to shaft.

(3) Slide thrust sleeve (R), collar first, onto shaft. Slide thrust bearing (S) onto sleeve. Press shaft bearing (T) onto end of shaft.

(4) Slide bearing (DD) and washer (CC) onto end of lever shaft (Z) which is grooved to receive snap ring (AA). Install snap ring in groove. Slide shaft into position in body from left (plain) side of body. Tap other shaft bearing (NN) and oil seal (PP) into position in body at other (right) end of shaft. Tap retainer into position in body over left end of shaft.

(5) Slide spring washer (X) onto fork shaft and insert fork shaft through lever shaft (Z) inside body. Be sure fork is on flattened side of lever shaft. Install hairpin-type clip (V) in groove on end of fork shaft.

(6) Insert a punch through pinhole in lever shaft. Use punch as a lever and turn shaft so fork points toward open end of body. Insert weight and shaft assembly into body. Twist lever shaft counterclockwise to position fork between collars on thrust sleeve as weight and shaft assembly is inserted. Tap bearing on end of shaft to seat in body. Remove punch from pinhole in lever shaft.

(7) Tap remaining shaft bearing to seat in flange. Position new gasket (G) on flange with notch in gasket alined with oil drain hole in flange. Slide flange assembly over protruding end of shaft. Twist flange so drain hole is alined with notch at bottom of body. Install the six lock washers and screws which attach flange to body.

(8) Screw nut (RR) onto eyebolt (SS) and insert eyebolt through bolt hole in lever (QQ) so that eye in eyebolt points in the opposite direction from lever. Install other nut on eyebolt. Position lever on shaft (Z) with lever pointing up. Tap taper pin (LL) to seat through lever hub and shaft.

(9) Piston spring guide (VV) (spring hole up) on body and install the two special screws fingertight. Clip spring into holes in guide and in eyebolt. Screw lock nut onto spring guide adjusting screw (KK) and install the screw through flange on front of governor. Tighten screw sufficiently to hold spring in position.

(10) Tap key (E) into keyway on shaft and press helical gear onto shaft. Install snap ring (A) into groove on end of shaft.

(11) Install copper gasket (GG) and screw (HH) in screw hole on lower front of body. Install drain plug in plug hole on under side of body. Screw oil elbow into elbow hole on top of body. Tighten elbow so it points toward front of governor. Install oil level plug in plug hole on front of body.

(12) Adjust governor to 1,200 revolutions per minute (subpar. d, above).

36. FUEL PUMP.

a. Disassembly (fig. 41).

(1) Loosen nut (V) on bail and screw at bottom of sediment bowl (Q). Swing bail out and remove bowl and gasket. Spread bail and remove bail and screw, nut, and bowl seat. Lift screen (K) from body.

(2) Remove screws which attach bottom cover (JJ) to body (V). Remove bottom cover, gasket, two springs, and spring cap.

(3) Remove air dome (A) and plug (B) from top cover. Lift the two gaskets, valve springs, and valves from top cover.

(4) Scribe-mark top cover and body to facilitate proper assembly. Remove screws and washers which attach top cover to body, and lift top cover from body.

(5) Remove snap ring (Z) from each end of linkage and arm attaching pin (AA), and tap pin from body. Remove arm (GG) from body.

(6) Remove hairpin-type clips (EE) from each end of the two link pins (DD). Remove pins, links, and diaphragm and rod assembly from body.

(7) From end of rod, remove nut (J), small washer (L), large washer (N), protector (P), diaphragm (R), protector (S), and washer (U), respectively.

b. Inspection.

(1) Clean all parts in dry-cleaning solvent, and dry with compressed air.

(2) Examine body, top cover, and bottom cover to see if metal is cracked or broken. Note condition of valve seats. Seats should be flat and free of pits and marks.

(3) Inspect valves and valve springs. Valves must be free of gummy residue and perfectly flat. Springs must be clean and neither stretched nor compressed. Do not stretch springs as that changes their tension and affects pump action adversely.

ORDNANCE MAINTENANCE—GENERATING UNIT M18

A—DOME—AC-855789
B—PLUG—AC-855135
C—GASKET—AC-855136
D—SPRING—AC-856270
E—SCREW—BCGX1.1BG-5
F—WASHER—BECX3E
G—VALVE—AC-855003
H—COVER—AC-1523358
J—NUT—BBBX1A-1
K—SCREEN—AC-854009
L—WASHER—AC-855390
M—GASKET—AC-854003
N—WASHER—AC-855029
P—PROTECTOR—AC-1521194
Q—BOWL—AC-854004
R—DIAPHRAGM—AC-855035
S—PROTECTOR—AC-855078
T—SEAT—AC-854005
U—WASHER—AC-855012
V—NUT—AC-855763
W—ROD—AC-855250
X—BAIL AND SCREW—AC-854016
Y—BODY—AC-1523760
Z—SNAP RING—AC-1521288
AA—PIN—AC-1521289
BB—CAP—AC-855532
CC—SPRING—AC-855253
DD—PIN—AC-855016
EE—CLIP—AC-855017
FF—LINK—AC-855374
GG—ARM—AC-856242
HH—GASKET—AC-855229
JJ—COVER—AC-855228
KK—SCREW—BCGX1.1BD-5

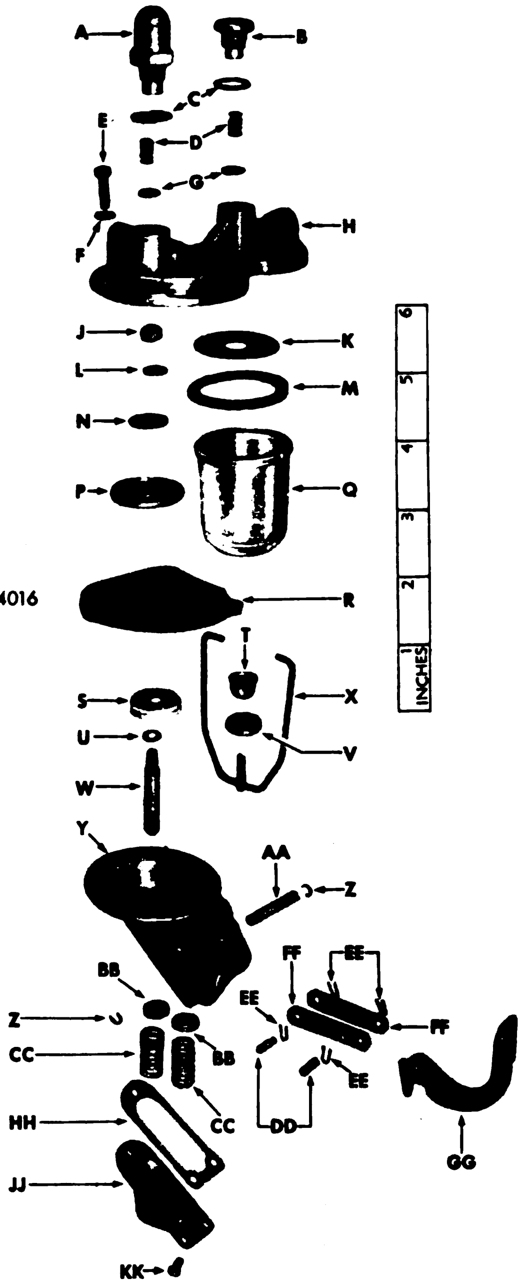


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Figure 41—Fuel Pump Disassembled

(4) Inspect diaphragm to see if it is torn (especially around screw and rod holes), wrinkled, or stretched.

(5) Examine all gaskets to see if any of them are torn, crushed, or compressed.

(6) Examine screen for breaks, tears, and sand or other foreign substances impregnated in screen.

(7) Inspect the pins for wear and check for elongated holes in the links and arm. Check section of arm which rides on camshaft for wear.

(8) Inspect remaining parts to see if any are bent, broken, or burred. Note condition of threads on threaded part.

c. Repair.

(1) Replace diaphragm and all gaskets unless they appear to be in new condition. Replace fuel assembly pump if not repairable with authorized spare parts.

(2) Clean off all burs with a fine smooth file.

(3) Smooth pitted valve seats by sanding them with a small disk of flint paper (class B, No. 00) glued to the end of a $^{17}/_{32}$-inch round iron rod. Place the end of rod bearing paper against valve seat. Oscillate rod until seat is smooth.

(4) Scrape gummy residue from valves, using care to keep from cutting or breaking them. Sand valves smooth after scraping. Inspect valves closely after cleaning and replace if condition does not appear perfect.

d. Assembly (fig. 41).

(1) On rod (W), place small washer (U); protector (S), with flat surface facing up; diaphragm (R); protector (P); large washer (N); small washer (L); and nut (J), respectively. Be sure diaphragm lies flat between protectors and that lips of protectors are away from diaphragm. Twist rod so that screw holes in diaphragm will aline with screw holes in body when flat sides of rod are parallel to flat sides of bottom cover (JJ). Tighten nut securely.

(2) Insert rod and diaphragm assembly into position in body. Assemble the two links (FF) to rod with pin (DD) and two clips (EE). Also install pin through center holes of links, and install clips. Position arm (GG) in body over link pin installed last. Install long pin (AA) through body, both links, and arm. Install the two snap rings (Z) on end of pin.

(3) Match scribe marks, on top cover and body, made during disassembly, and carefully position top cover on body over diaphragm. Be sure screw holes in cover, diaphragm, and body are perfectly alined without twisting diaphragm. If necessary, loosen nut (J) on rod (W)

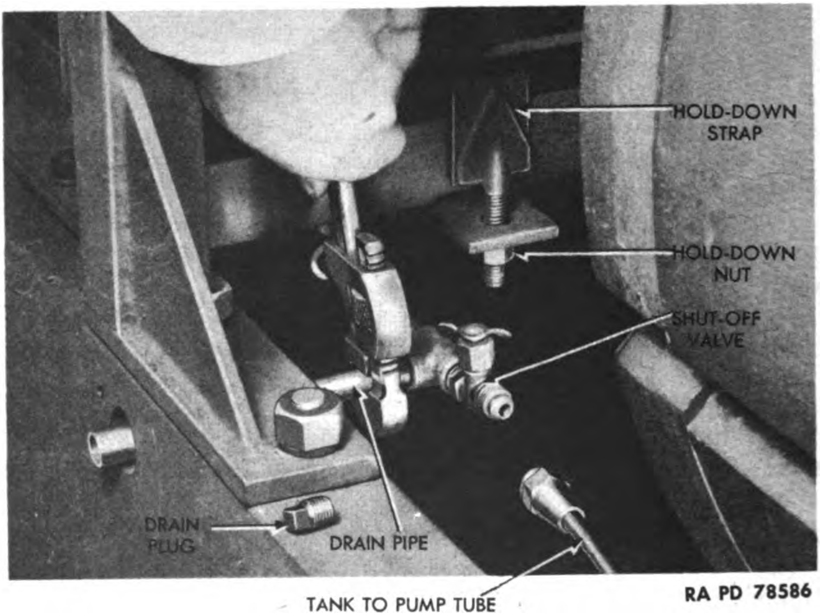

Figure 42—Gasoline Tank Removal (1)

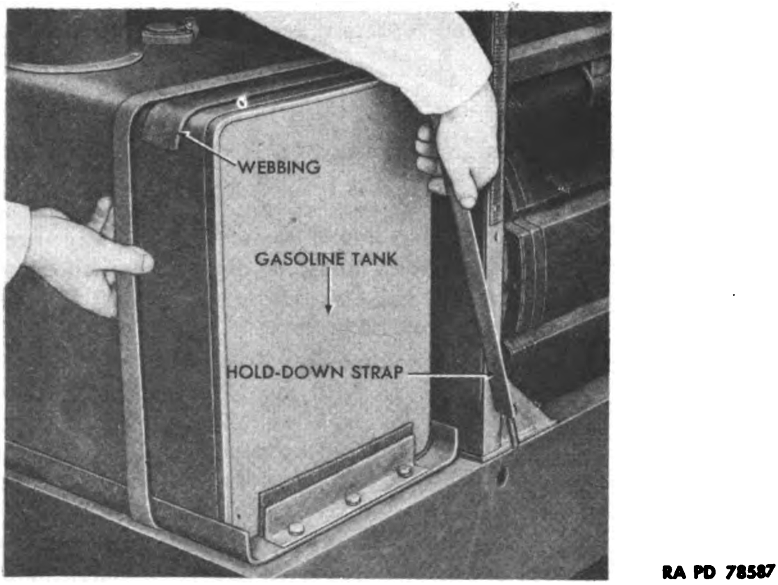

Figure 43—Gasoline Tank Removal (2)

and turn diaphragm to secure alinement, and retighten nut. Install screws and washers which attach cover to body.

(4) Position gasket (HH) on bottom cover. Place the two springs (CC) in position inside cover. Place spring caps (BB) on springs. Carefully position cover (JJ) to body, making sure spring caps engage bottom of push rod (W) and lug on arm (GG). Install the three screws which attach cover to body.

(5) Place a valve (C) on each valve seat in top cover. Position a valve spring on each valve. Slide gasket onto air dome and valve plug. Screw air dome tightly into valve boss adjacent to pump outlet. Screw valve plug tightly into valve boss over sediment bowl.

(6) Place screen (K) in position on under side of top cover. Screw nut (V) onto screw on bail. Place bowl seat (T) on nut. Hook bail to top cover. Position bowl gasket (M) on bowl, and bowl to top cover. Swing bail under bowl and tighten nut.

37. GASOLINE TANK.

a. **Removal** (figs. 42 and 43).

(1) Remove drain plug from end of drain pipe and drain all fuel from tank into clean container.

(2) Disconnect tank-to-pump tube from shut-off valve near tank. Screw drain pipe from tee. Screw nipple, tee, and shut-off valve (as an assembly) from elbow beneath tank.

(3) Remove gasoline tank guards and gasoline tank guard plate.

(4) Remove hold-down nut and washer from stud on each hold-down strap assembly. Bend straps back away from tank. Lift the two pieces of webbing from top of tank. Lift tank from gasoline tank support.

(5) To remove tank hold-down straps, remove the two screws which attach each strap to gasoline tank support.

b. **Disassembly** (fig. 44).

(1) Unscrew pipe plug, elbow, and nipple from bosses on under side of tank.

(2) Remove the four screws which attach gage to tank. Lift gage assembly and synthetic rubber washer from tank.

(3) Screw cap counterclockwise from filler neck. Screw screen assembly counterclockwise from filler neck. Remove the eight screws and lock washers which attach cap and screen assembly body to tank filler neck. Lift body and gasket from filler neck.

(4) To disassemble cap, remove cotter pin from end of valve on under side of cap. Slide chain, washer, and spring from valve. Remove

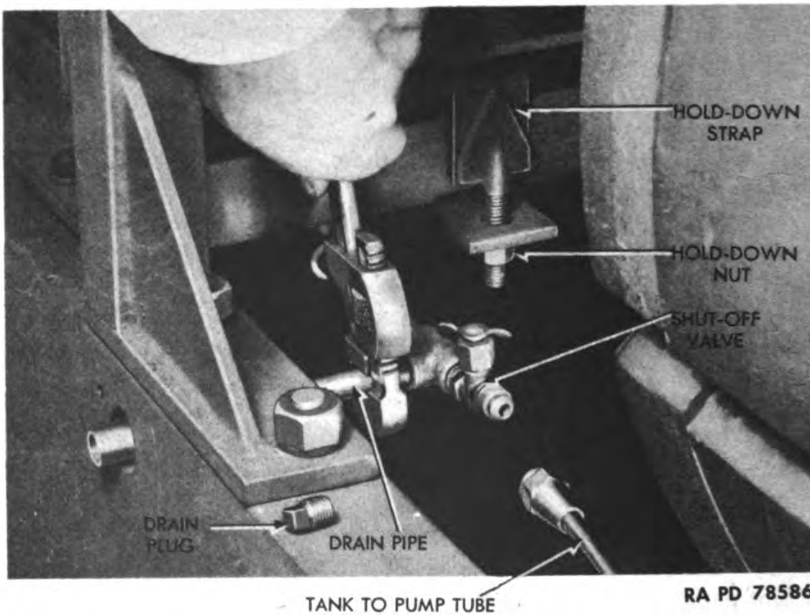

Figure 42—Gasoline Tank Removal (1)

Figure 43—Gasoline Tank Removal (2)

and turn diaphragm to secure alinement, and retighten nut. Install screws and washers which attach cover to body.

(4) Position gasket (HH) on bottom cover. Place the two springs (CC) in position inside cover. Place spring caps (BB) on springs. Carefully position cover (JJ) to body, making sure spring caps engage bottom of push rod (W) and lug on arm (GG). Install the three screws which attach cover to body.

(5) Place a valve (C) on each valve seat in top cover. Position a valve spring on each valve. Slide gasket onto air dome and valve plug. Screw air dome tightly into valve boss adjacent to pump outlet. Screw valve plug tightly into valve boss over sediment bowl.

(6) Place screen (K) in position on under side of top cover. Screw nut (V) onto screw on bail. Place bowl seat (T) on nut. Hook bail to top cover. Position bowl gasket (M) on bowl, and bowl to top cover. Swing bail under bowl and tighten nut.

37. GASOLINE TANK.

a. **Removal** (figs. 42 and 43).

(1) Remove drain plug from end of drain pipe and drain all fuel from tank into clean container.

(2) Disconnect tank-to-pump tube from shut-off valve near tank. Screw drain pipe from tee. Screw nipple, tee, and shut-off valve (as an assembly) from elbow beneath tank.

(3) Remove gasoline tank guards and gasoline tank guard plate.

(4) Remove hold-down nut and washer from stud on each hold-down strap assembly. Bend straps back away from tank. Lift the two pieces of webbing from top of tank. Lift tank from gasoline tank support.

(5) To remove tank hold-down straps, remove the two screws which attach each strap to gasoline tank support.

b. **Disassembly** (fig. 44).

(1) Unscrew pipe plug, elbow, and nipple from bosses on under side of tank.

(2) Remove the four screws which attach gage to tank. Lift gage assembly and synthetic rubber washer from tank.

(3) Screw cap counterclockwise from filler neck. Screw screen assembly counterclockwise from filler neck. Remove the eight screws and lock washers which attach cap and screen assembly body to tank filler neck. Lift body and gasket from filler neck.

(4) To disassemble cap, remove cotter pin from end of valve on under side of cap. Slide chain, washer, and spring from valve. Remove

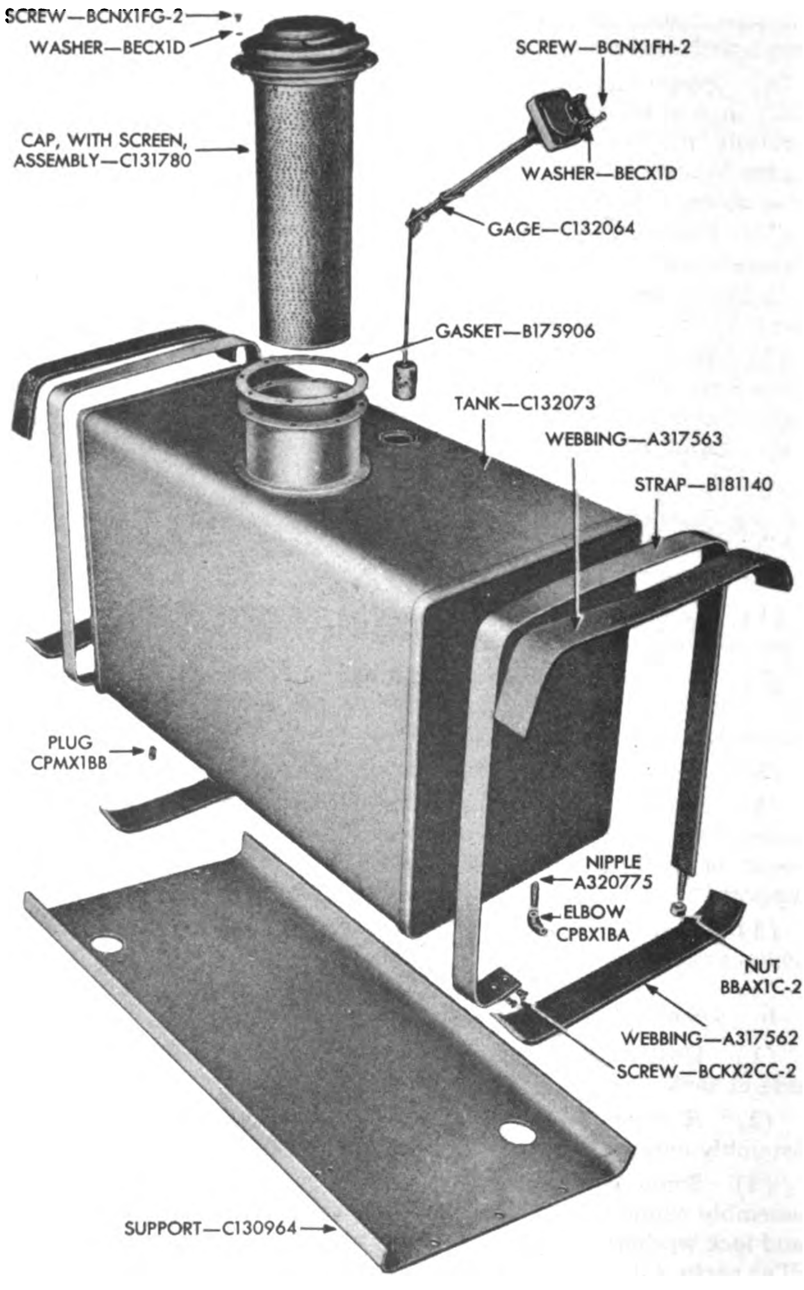

Figure 44—Gasoline Tank Disassembled

four screws from cap cover. Lift cover, valve, gasket, and handle from cap. Shake valve to remove washer (plug), spring, and valve (ball) from valve body.

c. Inspection.

(1) Clean all parts in dry-cleaning solvent, and wipe dry with a clean cloth.

(2) Inspect exterior of tank for discoloration which indicates leakage.

(3) Tip tank from side to side and listen for noise which indicates presence of foreign objects in tank.

(4) Reach through filler neck and test baffle for security of attachment.

(5) Examine tank for dents which might affect strength of capacity of tank.

(6) Lift gage float through its arc of operation and observe dial to see if it registers correctly.

(7) Inspect all parts of cap and screen assembly to see if any are bent, broken, or badly worn.

(8) Inspect straps to see if they are bent or broken. Note condition of threads on studs, nuts, and attaching screws.

(9) Inspect webbing to see if it is torn, crushed, or deteriorated.

d. Repair.

(1) Repair leaks in tank by soldering or welding. CAUTION: *Have tank completely filled with water, or carbon dioxide gas from dry ice, before bringing an open flame near it.*

(2) Empty foreign objects from tank. In case of sand or a similar substance, clean tank with dry-cleaning solvent.

(3) Reach through filler neck and solder baffle in place if it is loose. Use a soldering iron. *Do not use a torch.*

(4) Bump out serious dents by reaching through filler neck. If dent is behind baffle, solder an L-shaped bar of solder to center of dent on outside of tank. Hit the bar with sharp blows to pull metal to proper position. Heat solder and remove bar from tank. If a torch or other open flame is used to heat solder, first fill tank with water or place dry ice in tank.

(5) Replace tank if it is damaged beyond proper repair.

(6) Replace all bent, broken, or badly worn parts of cap and screen assembly.

(7) Straighten straps if bent. Weld or replace if broken. Replace threaded parts if stripped. Replace crushed, torn, or deteriorated webbing.

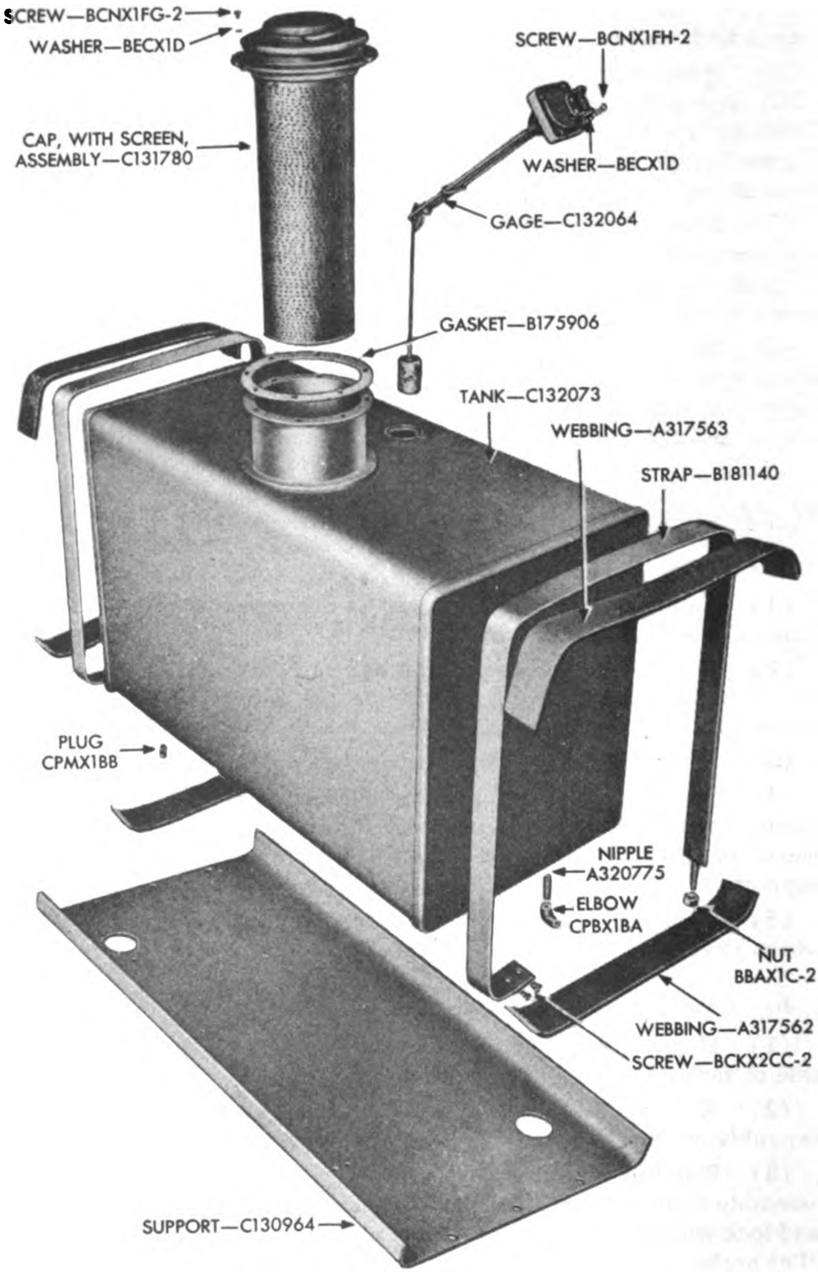

Figure 44—Gasoline Tank Disassembled

four screws from cap cover. Lift cover, valve, gasket, and handle from cap. Shake valve to remove washer (plug), spring, and valve (ball) from valve body.

c. Inspection.

(1) Clean all parts in dry-cleaning solvent, and wipe dry with a clean cloth.

(2) Inspect exterior of tank for discoloration which indicates leakage.

(3) Tip tank from side to side and listen for noise which indicates presence of foreign objects in tank.

(4) Reach through filler neck and test baffle for security of attachment.

(5) Examine tank for dents which might affect strength of capacity of tank.

(6) Lift gage float through its arc of operation and observe dial to see if it registers correctly.

(7) Inspect all parts of cap and screen assembly to see if any are bent, broken, or badly worn.

(8) Inspect straps to see if they are bent or broken. Note condition of threads on studs, nuts, and attaching screws.

(9) Inspect webbing to see if it is torn, crushed, or deteriorated.

d. Repair.

(1) Repair leaks in tank by soldering or welding. CAUTION: *Have tank completely filled with water, or carbon dioxide gas from dry ice, before bringing an open flame near it.*

(2) Empty foreign objects from tank. In case of sand or a similar substance, clean tank with dry-cleaning solvent.

(3) Reach through filler neck and solder baffle in place if it is loose. Use a soldering iron. *Do not use a torch.*

(4) Bump out serious dents by reaching through filler neck. If dent is behind baffle, solder an L-shaped bar of solder to center of dent on outside of tank. Hit the bar with sharp blows to pull metal to proper position. Heat solder and remove bar from tank. If a torch or other open flame is used to heat solder, first fill tank with water or place dry ice in tank.

(5) Replace tank if it is damaged beyond proper repair.

(6) Replace all bent, broken, or badly worn parts of cap and screen assembly.

(7) Straighten straps if bent. Weld or replace if broken. Replace threaded parts if stripped. Replace crushed, torn, or deteriorated webbing.

e. Assembly (fig. 44).

(1) Assemble cap as follows: Insert valve (ball), spring, and washer (plug) into valve assembly. Position handle, gasket, valve, and cover on top of cap. Install the four screws which attach cover to cap. Slide spring and washer onto lower end of valve. Install chain and cotter pin on lower end of valve.

(2) Position gasket and cap and screen assembly body on filler neck of tank. Install the eight lock washers and screws which attach body to tank. Screw screen assembly into body. Screw cap into body.

(3) Position gage in tank so that float extends toward rear of tank. Install the four screws which attach gage to tank.

(4) Screw pipe plug into left rear boss on bottom of tank. Screw nipple and elbow into right front boss on bottom of tank. Tighten elbow so it points toward front of tank.

f. Installation (figs. 42 and 43).

(1) Position the two tank straps on gasoline tank support. Install the two screws which attach each strap to support.

(2) Place three pieces of webbing on gasoline tank support and set tank in position on webbing. Bend straps around tank and insert strap studs through their supports. Slide a length of webbing between top of tank and each strap. Install washer and nut on each strap stud.

(3) Install nipple, tee, and shut-off valve in elbow under tank. Tighten securely. Install drain pipe into tee and drain plug into pipe. Connect tank to pump fuel tube to shut-off valve.

(4) Fill tank with gasoline and inspect connections for leaks. Absence of leaks indicates satisfactory installation.

(5) Install gasoline tank guard plate and guards.

38. GASOLINE LINES AND VALVES.

a. Inspection.

(1) TUBING. Blow out with compressed air and inspect for cracks Pay particular attention to ends of tubing beneath nuts. Look for sharp kinks which might obstruct tube. Examine nuts for cracks or stripped threads.

(2) VALVES. Visually inspect valves for cracks and stripped threads. Test operation by attempting to blow through valve when open and when closed.

b. Repair.

(1) TUBING BROKEN UNDER NUT.

(a) Shove nut back from end of tubing and saw off cracked end of tubing.

(b) Flare end of tubing and pull nut back in place.

(2) TUBING KINKED. Kinked tubing often breaks when straightened. Attempt to straighten kink. Inspect carefully for evidence of breaking. Blow through tubing to see if it is obstructed.

(3) TUBING SPLIT. Replace split tubing. If no replacement is available, make temporary repair by soldering break. Be sure ends are open when soldering tubing.

(4) NUT INSTALLATION. Examine end of tubing. If cut at an angle, saw off square. Slide nut on tubing, with threaded end of nut toward end of tubing. Flare end of tubing.

(5) VALVES. Replace valves which do not operate correctly or which have stripped threads.

Section IV

EXHAUST SYSTEM

39. DESCRIPTION.

a. **General** (fig. 45). The exhaust system is composed of a manifold, an exhaust tube, a muffler, and a flexible exhaust pipe. Through this system the exhaust gases are conducted from the engine. The exhaust system discharges these gases to the atmosphere at the front of the unit.

b. **Manifold** (fig. 46). The exhaust manifold, together with the intake manifold, is of one-piece cast iron construction. It is attached to the right side of cylinder block by 10 bolts. The exhaust from the engine cylinders is collected by the exhaust manifold and passed through the exhaust tube to the muffler. A heat control valve is located in the exhaust manifold, and is designed to direct the exhaust gases through passages to heat the intake portion of the manifold during cold weather operation. The valve is manually adjusted by a lever, which is held in position by a spring. To adjust valve, slide lever to "HOT" position for cold weather operation and to "COLD" position for warm weather operation.

c. **Exhaust Tube** (fig. 48). The exhaust tube is constructed of heavy sheet steel. It is approximately 14 inches long and 2⅜ inches in diameter. The tube fits onto a split sleeve on the muffler and is secured to it with a clamp. The outside of tube is covered with a sheet of asbestos. An expanded metal lath insulation cover holds the asbestos cover in place.

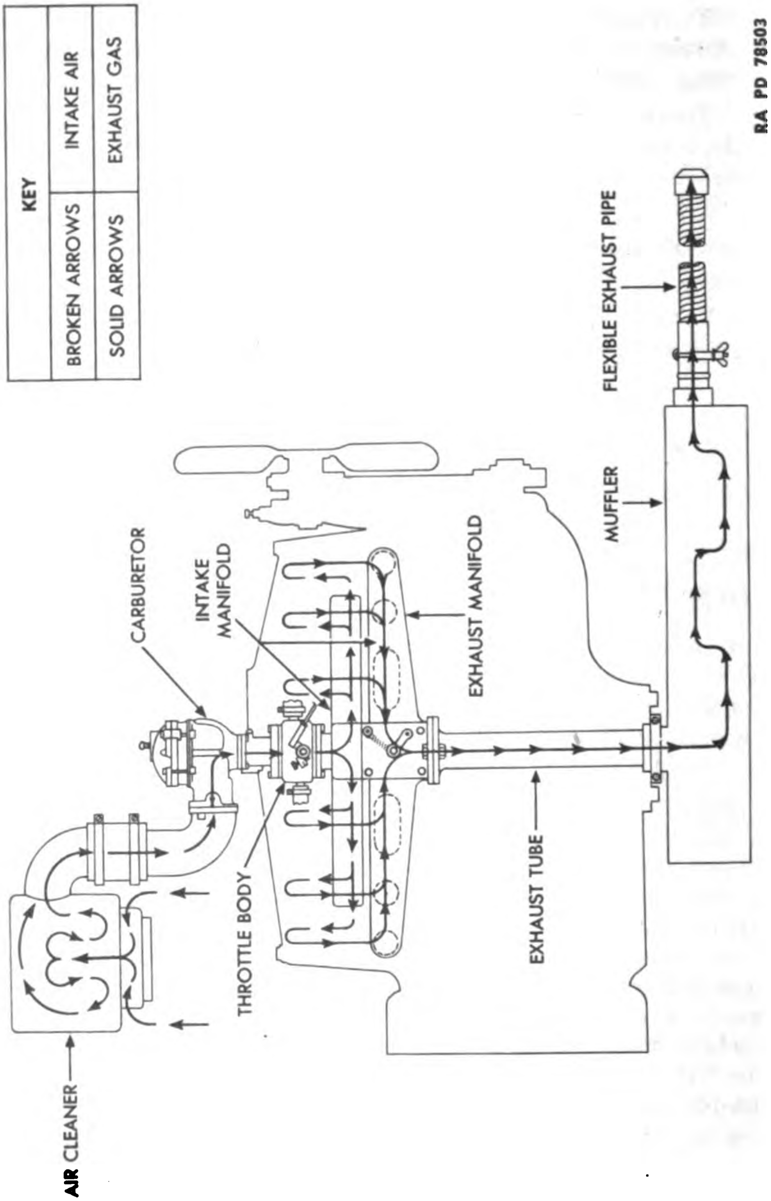

Figure 45—Intake and Exhaust System Diagram

d. Muffler (fig. 49). Muffler is of welded sheet steel construction. It is cylindrical in shape, and is about 34½ inches in length. It is insulated in the same manner as the exhaust tube.

e. Flexible Exhaust Pipe (fig. 45). The flexible exhaust pipe consists of a length of flexible steel tubing with a sheet steel sleeve welded to each end. The sleeve on the attaching end is split and equipped with a clamp consisting of a circular clamp bolt with a wing nut. This clamp is spot-welded to the sleeve. Over-all length of the assembly is approximately 44 inches.

40. MANIFOLD.

a. Disassembly.

(1) Remove four nuts from studs which attach valve assembly to exhaust manifold and remove valve assembly and gasket (fig. 46).

(2) Unhook and remove spring from shaft and clip on valve assembly (fig. 47).

(3) Drive out two pins which secure shaft to valve and slide shaft from plate and valve (fig. 47).

(4) Drive out pin which attaches lever to shaft, and remove lever from shaft (fig. 47).

(5) Remove the four studs which attach the plate to manifold (fig. 46).

(6) Screw crankcase breather valve from intake manifold.

b. Inspection and Repair.

(1) At frequent intervals, examine manifold for cracks; repair by welding or by replacing manifold.

(2) Use new gaskets whenever the old ones are removed.

(3) Check studs which attach manifold to cylinder block for tightness. If threads are damaged or stripped, replace studs.

(4) Check spring for sufficient tension, and replace if weak.

(5) Check dowels for tightness.

c. Assembly (figs. 46 and 47).

(1) Screw crankcase breather valve into tapped hole at rear of intake manifold.

(2) Install the four studs which attach valve assembly to manifold.

(3) Position shaft onto lever and line up drilled holes. Drive in pin which secures lever to shaft. Peen the end of the pin.

(4) Slide shaft onto plate and valve, and line up pinholes. Drive in and peen the two pins which secure shaft to valve.

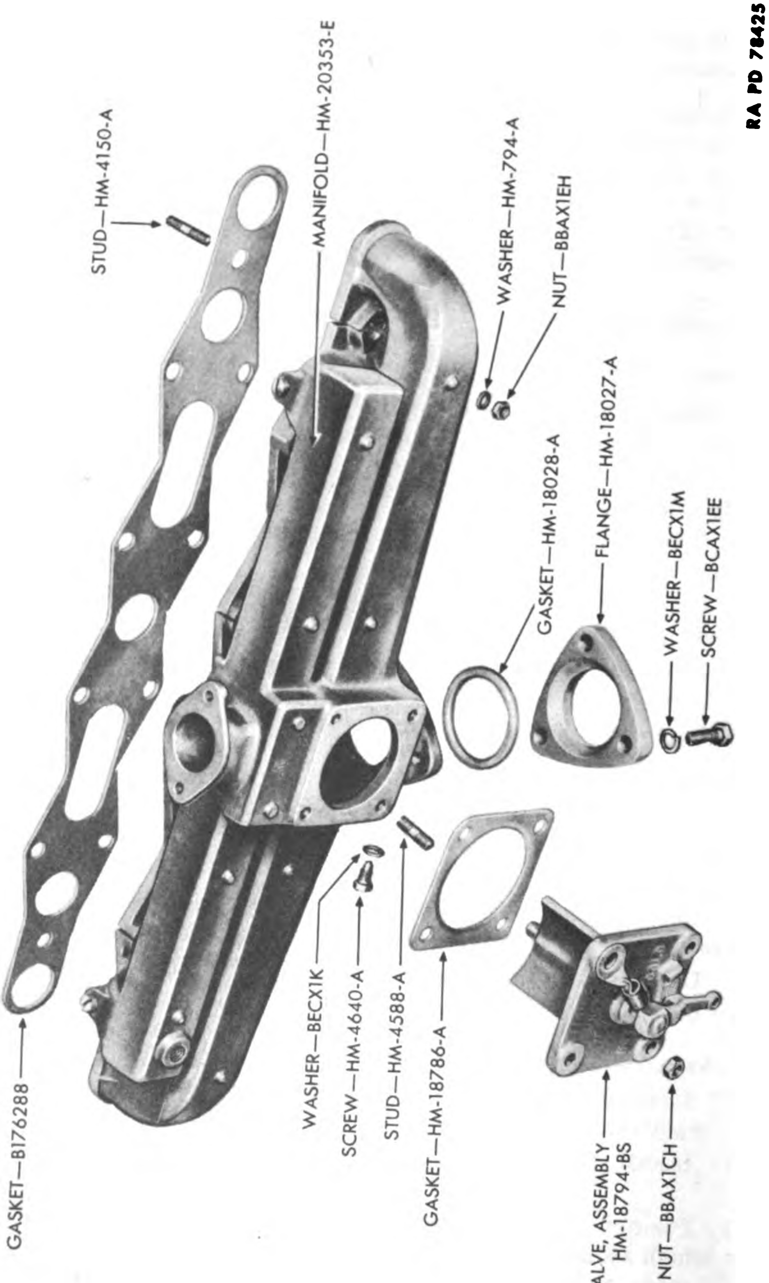

Figure 46—Manifold Disassembled

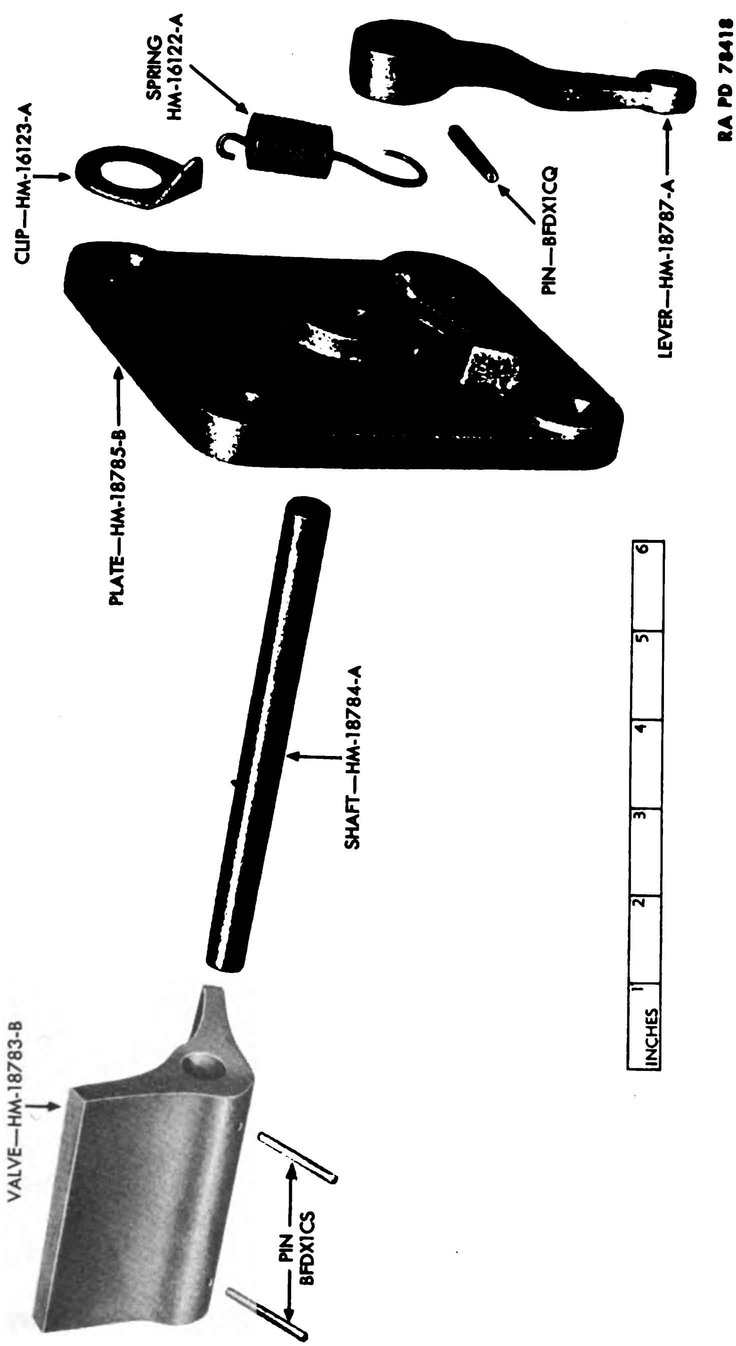

Figure 47—Manifold Heat Control Valve Disassembled

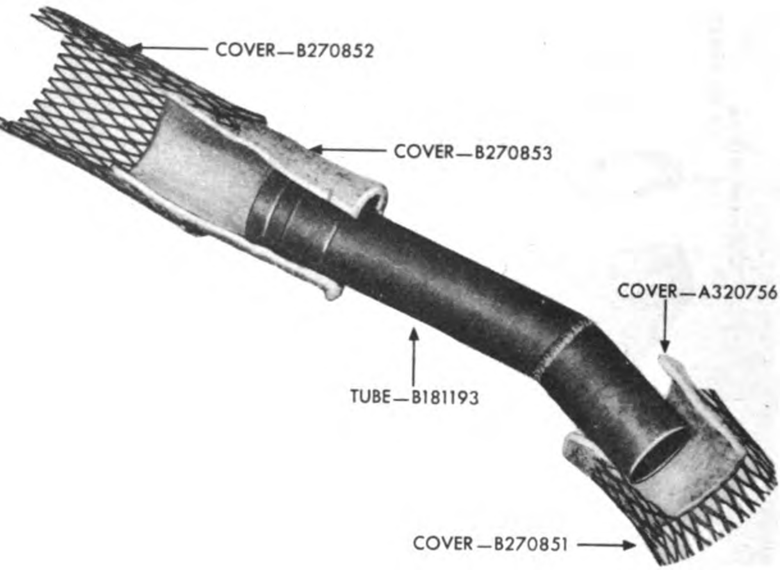

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Figure 48—Exhaust Tube Disassembled

(5) Hook spring onto clip and shaft.

(6) Place gasket and plate assembly in position. Slip clip onto stud at upper right-hand corner of plate.

(7) Install and tighten four nuts which attach plate assembly to manifold.

41. EXHAUST TUBE.

a. Disassembly (fig. 48).

(1) Slide asbestos insulating covers and expanded metal lath insulation covers from tube.

(2) Unhook insulation covers and remove insulating covers from them.

b. Inspection and Repair.

(1) Clean sheet metal with wire brush.

(2) Examine sheet metal for dents serious enough to restrict passages of gases. Also examine for cracks or breaks.

(3) Examine asbestos covers. If torn sufficiently to prevent proper insulation, replace cover.

(4) Examine expanded metal lath insulation cover. Replace covers if broken.

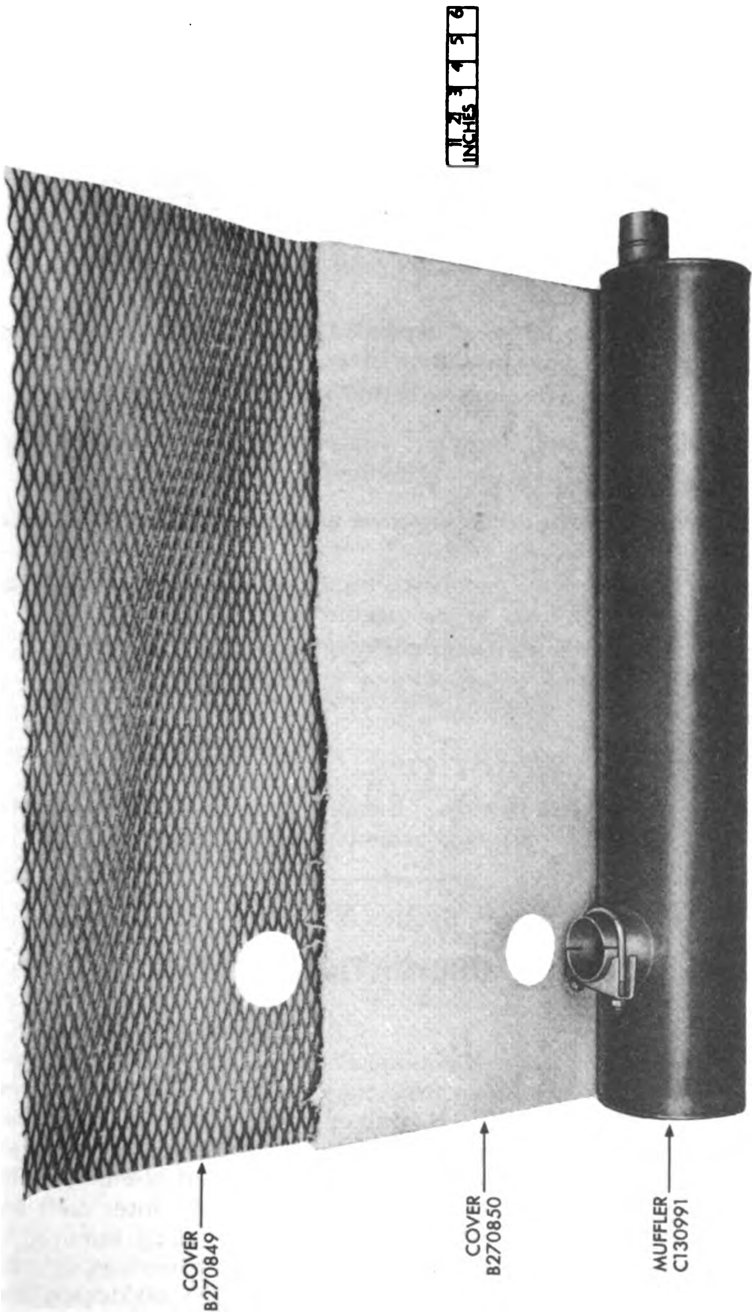

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Figure 49—Muffler Disassembled

c. Assembly (fig. 48).

(1) Wrap top and bottom pieces of asbestos insulating cover around exhaust pipe.

(2) Wrap expanded metal lath insulation cover around asbestos, and hook edges of metal together.

42. MUFFLER.

a. Disassembly (fig. 49).

(1) Remove two nuts, washer, and U-bolt from muffler clamp. Lift clamp from muffler.

(2) Unhook two edges of expanded metal lath insulation cover from each other. Remove insulation cover.

(3) Unwrap and remove asbestos muffler insulating cover.

b. Inspection and Repair. See paragraph 41 b.

c. Assembly (fig. 49).

(1) Wrap asbestos insulating cover around muffler. Hold asbestos in position with masking tape.

(2) Wrap expanded metal lath insulation cover around asbestos insulating cover and hook edges together.

(3) Place muffler clamp in position on muffler split sleeve.

(4) Install U-bolt, washers, and nuts which secure clamp to muffler sleeve.

43. FLEXIBLE EXHAUST PIPE.

a. Inspection and Repair. Examine flexible tubing to see if it is broken or crushed. Replace assembly if damaged.

Section V

ENGINE LUBRICATION SYSTEM

44. DESCRIPTION.

a. General (fig. 50). Continuous lubrication is provided by a submerged type pump driven from the camshaft. The pump draws its oil through a screen type oil strainer from a sump in the oil pan. The oil is pumped under pressure through the filter pads and into the outlet pipe located in the center of the filter pad assembly. Dirt and foreign substances collect on the outside of the filter pads and drop to the bottom of the filter where they can be easily removed by means of the drain plug. Rear and center camshaft bearings, cylinder walls, pistons, and valve tappets are all lubricated by oil thrown from the main and connecting rod bearings.

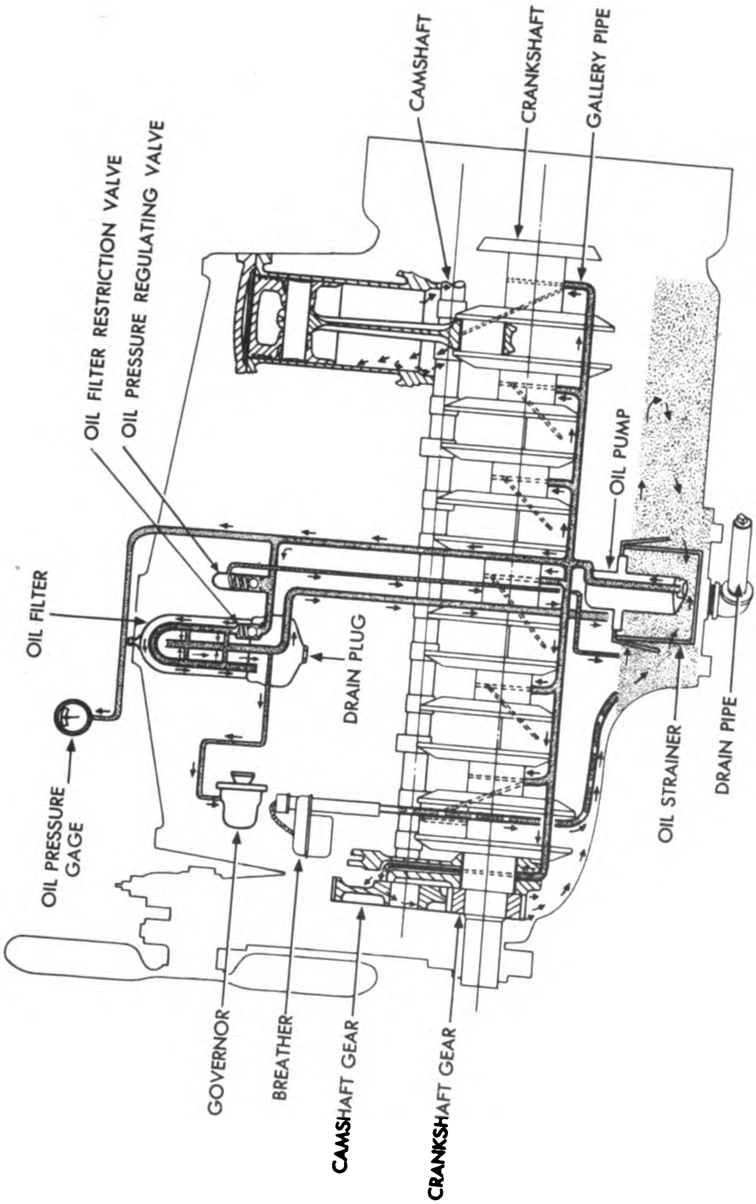

Figure 50—Engine Oil System Diagram

b. Crankcase Ventilation. A crankcase ventilating metering valve is installed on the right side of the engine, toward the rear (fig. 19). One end is connected to an opening in the crankcase, and the other end is connected to an opening in the intake manifold. The crankcase breather is located on the left side of the engine. The metering valve is a spring-loaded, one-way valve, operated by high manifold vacuum. Its action is to draw vapors from the crankcase and pass them off through the intake manifold, providing forced ventilation of the crankcase by this means, as a substitute for the forced ventilation which would ordinarily be produced by the forward motion of the vehicle.

c. Oil Filter (fig. 50). The oil filter is a casing which contains felt pads about a center tube and a base. The base contains a drain plug and an adjustable spring and plunger type pressure regulating valve. The oil is pumped under pressure up through the filter pads. It comes out at the top and flows down through a filter tube, leaving dirt and foreign substances at the bottom of the filter where they can be easily removed by means of the drain plug.

d. Oil Strainer (fig. 50). The oil strainer is a wire mesh cylinder welded to a removable cap at the bottom of the crankcase. A drain pipe attached to an elbow in the center of the cap provides the means for draining oil. The oil pump draws the oil through the wire mesh.

e. Oil Pump (fig. 50). The oil pump is a spur gear type. Its principal parts are a body, a long shaft with a helical drive gear on top end and a spur gear on the other end, and a short shaft on which the other spur gear rides. The two spur gears are submerged in the oil. As these meshing gears rotate, oil is set in motion by the paddle action of their teeth, and forced through the system.

45. OIL FILTER.

a. Removal (fig. 51).

(1) Remove sludge drain screw and drain sludge and oil from oil filter.

(2) Disconnect oil pressure gage tubing from elbow fitting on back of oil filter base.

(3) Remove the four filter-to-crankcase bolts and lock washers. Lift filter and gasket from cylinder block.

b. Disassembly (figs. 52 and 53).

(1) Screw retainer fitting from top of shell. Lift washer from top of shell. Screw nut from fitting. Lift shell and gasket from base.

(2) Screw filter assembly from base. From bottom of filter tube, remove nut, spring, washer A317524, washer A317530, washer A317531, 17 felt washers which make up element, and spring A317526. From top of tube, unscrew threaded washer and male nut. Empty ball and spring A317522 from top of tube.

(3) From rear of base, unscrew elbow; from bottom of base, unscrew drain plug and remove plug gasket; from left side of base, remove acorn nut, gasket, adjusting screw lock nut, gasket, adjusting screw, spring, and plunger; and from tube on top of base, remove plug, spring, and ball.

c. **Inspection.**

(1) Clean all parts in dry-cleaning solvent, and dry with compressed air.

(2) Inspect all springs to see if any are bent, broken, rusted, or corroded.

(3) Examine all screws, nuts, plugs, washers, retainer, and valves to see if any are broken, bent, burred, noticeably worn, or if any have stripped threads.

(4) Inspect shell and base for cracks or breaks.

(5) Check condition of plunger and plunger seat.

(6) Examine felt washers to see if they are matted or saturated with gummy substance.

d. **Repair.**

(1) Remove burs from all parts with a fine mill file.

(2) Replace all gaskets.

(3) Clean felt washers in dry-cleaning solvent, if possible. Otherwise replace them.

(4) Remove obstructions from all passages and holes in base and filter tube with wire ramrod or compressed air.

e. **Assembly** (figs. 52 and 53).

(1) Insert plunger (flat end first) and spring A317510 into valve hole on left side of base. Screw adjusting screw in over spring to the approximate location it was before disassembly. Install gasket and lock nut on adjusting screw. Install gasket and acorn nut fingertight on adjusting screw.

(2) Install gasket and drain screw into bottom of base and elbow fitting on rear of base. Tighten elbow so it points up. In tube on top of base, install ball, spring A317511, and plug.

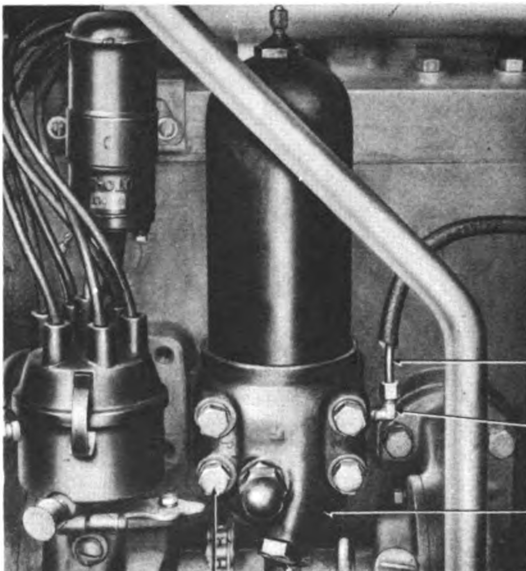

Figure 51—Oil Filter Installed

(3) Into top of element tube A317529, install spring A317522, ball, and nut. Screw threaded washer A317523 onto top of tube. Onto lower end of tube, install spring spacer A317526, 17 felt washers which compose purifier, washer A317531, washer A317530, washer A317524, spring A317525, and nut respectively. Screw element assembly into base.

(4) Position shell gasket and shell on base. Install gasket and retainer on element tube at top of shell. Screw cap onto retainer.

f. Installation (fig. 51).

(1) Position new gasket and oil filter assembly on cylinder block. Install the four lock washers and bolts which attach filter assembly to block.

(2) Connect oil pressure gage tubing to elbow on rear of filter base.

(3) Start engine, allow to warm up, and adjust oil pressure to 25 pounds.

(4) Check quantity of oil in crankcase and add if necessary.

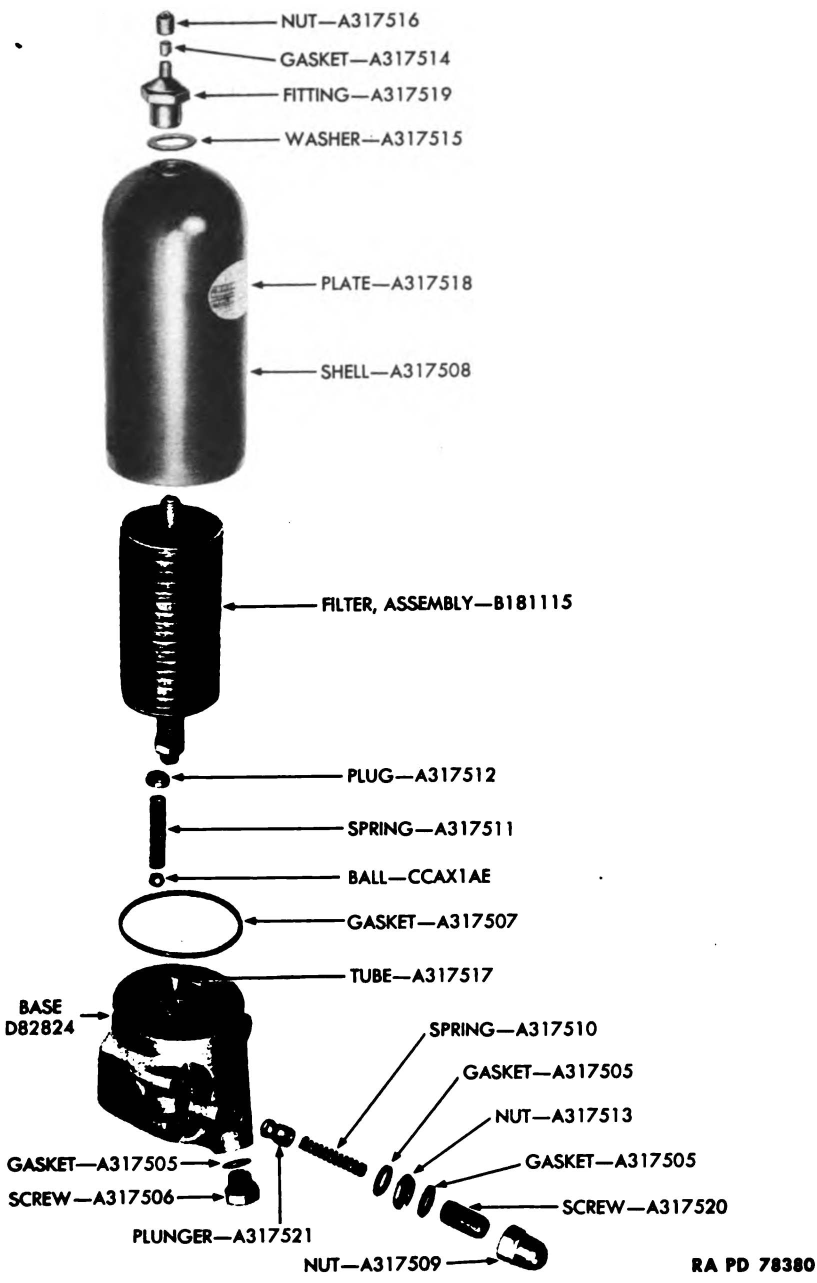

Figure 52—Oil Filter Disassembled

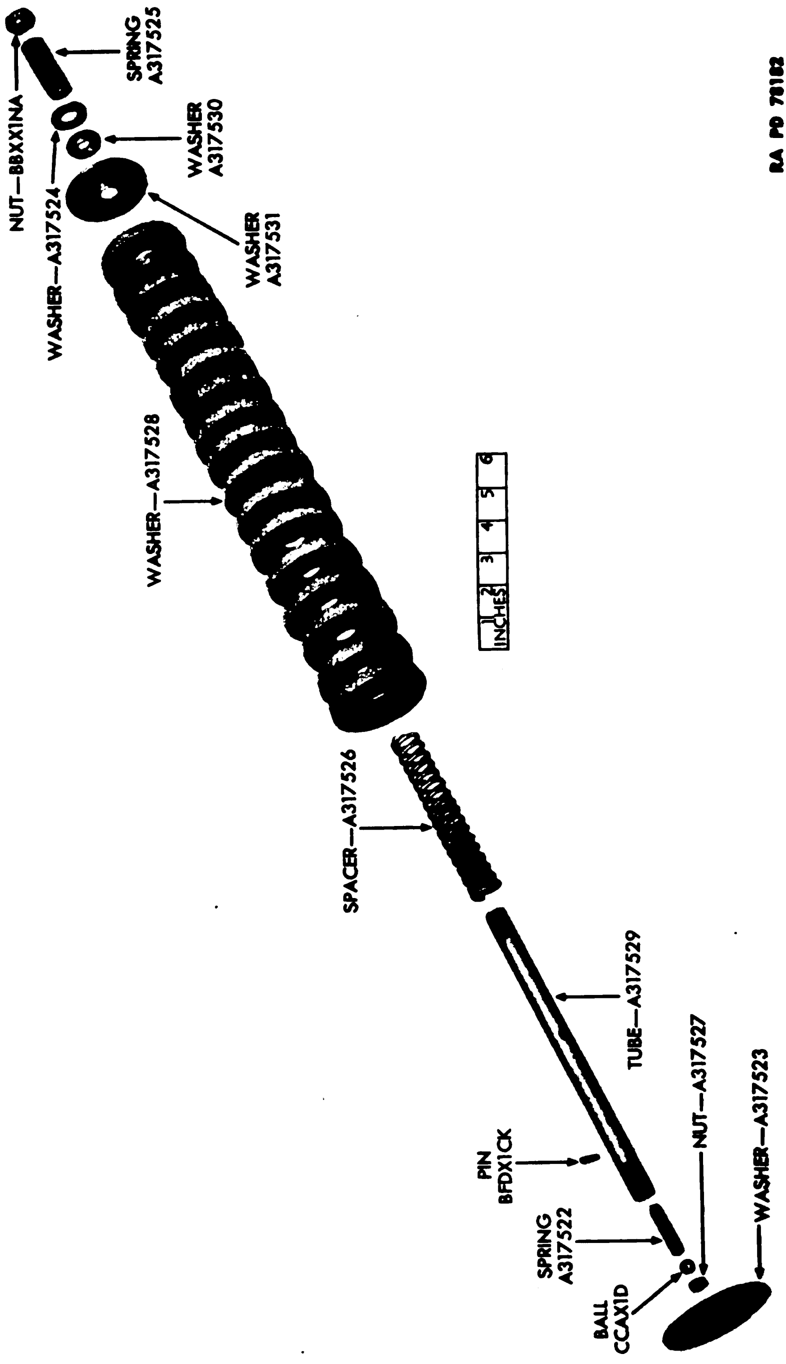

Figure 53—Oil Filter Element Disassembled

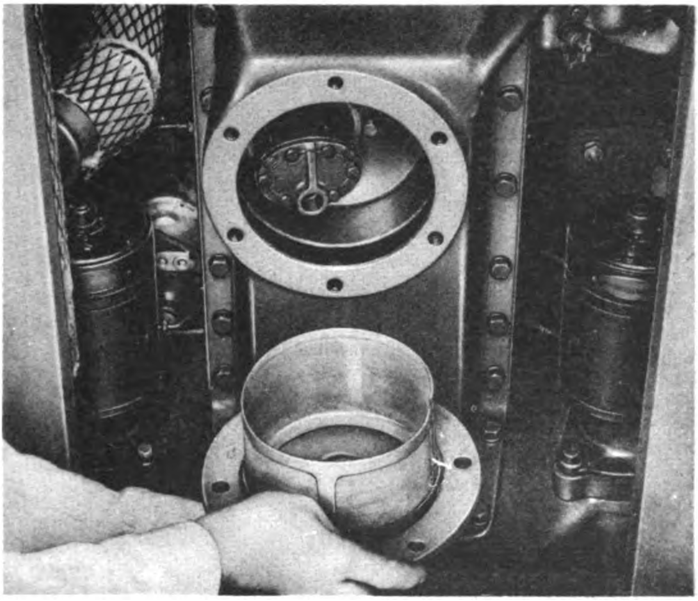

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Figure 54—Engine Oil Strainer Removal

46. OIL STRAINER.

a. **Removal** (fig. 54).

(1) Drain oil from engine.

(2) Hoist front end of unit and remove front bottom main frame cover.

(3) Screw oil drain pipe from elbow on underside of strainer.

(4) Remove cap screws and lock washers which attach strainer to oil pan. Lift strainer and gasket from oil pan.

b. **Disassembly.** Screw elbow from strainer.

c. **Inspection and Repair.**

(1) Wash parts in dry-cleaning solvent, and dry with compressed air. Blow wire mesh clean.

(2) Inspect wire mesh to see if it is torn. Note condition of threads on elbow and female threads in strainer. Scrape all dirt and sludge from frame, screen, and elbow. Examine attaching cap screws and lock washers to see if any are bent, broken, stripped, or sprung. Inspect gasket to see if it is torn, compressed, or otherwise damaged.

(3) File burs off all parts. Replace bent, broken, sprung, or stripped parts. Replace gasket if damaged.

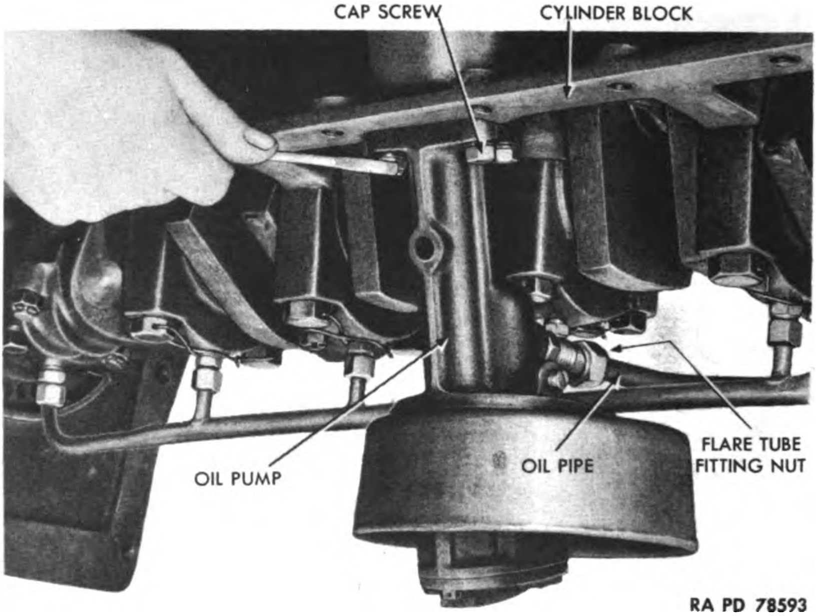


Figure 55—Oil Pump Removal

d. **Assembly.** Apply white lead pigment to threaded portion of elbow. Screw elbow tightly into underside of strainer so it points midway between two adjacent cap screw holes.

e. **Installation** (fig. 54).

(1) Position gasket on strainer. Position strainer to oil pan so that elbow points to left. Install the six lock washers and cap screws which attach strainer to oil pan.

(2) Screw oil drain pipe tightly into elbow.

(3) Install front bottom main frame cover and lower unit to ground.

(4) Install engine oil and inspect for leaks.

47. OIL PUMP.

a. **Removal** (fig. 55).

(1) Remove engine from unit (par. 58 c) and block assembly high enough to remove oil pan. Removal of engine is necessary, as pan cannot be removed due to structural interference.

(2) Remove oil pan from engine.

(3) Disconnect oil pipe from oil pump by unscrewing flare tube fitting nut.

(4) Remove the four cap screws and lock washers which attach pump to cylinder block. Lift pump from engine.

b. Disassembly (fig. 56).

(1) Remove safety wire from screws which attach baffle shell to pump body. Remove screws and lift shell and gasket from body.

(2) Remove safety wire from screws which attach cover to underside of pump. Remove screws and lift cover from pump.

(3) Remove snap rings which hold spur gears to shafts. Pull gears from shafts. Pull idler shaft from pump body. Tap key from keyway in each shaft.

(4) Pull drive shaft from top of body. Slide washer from shaft. Drive out pin which holds drive gear to shaft. Press gear from shaft.

(5) Screw plug and oil tube fitting from body.

c. Inspection.

(1) Wash all parts in dry-cleaning solvent, and dry with compressed air.

(2) Inspect drive and idler shafts to see if either is scored or has spread or burred keyways. Test fit of shafts in bushings in body. They should be free running fits without side play.

(3) Examine all gears to see if any are chipped, nicked, broken, burred, or have spread keyways.

(4) Examine keys to see if any are bent or burred.

(5) Inspect body, cover, and shell to see if they are cracked, broken, or burred. Examine threads tapped in screw holes.

(6) Inspect screws, snap rings, and pin to see if any are bent, broken, or burred. Examine threads on screws to see if they are stripped.

(7) Examine shell gasket to see if it is torn or crushed.

d. Repair.

(1) Remove burs from all parts with a fine mill file.

(2) Replace gears which are chipped, nicked, broken, or which have spread keyways.

(3) Clean up slightly damaged screw-hole threads with a thread tap. Replace parts having stripped threads.

(4) Replace shell gasket if torn or crushed.

e. Assembly (fig. 56).

(1) Screw plug and oil tube fitting into their respective bosses in body.

(2) Tap key into position in keyway in top end of drive shaft. Press helical drive gear onto shaft and key. Drive pin through gear

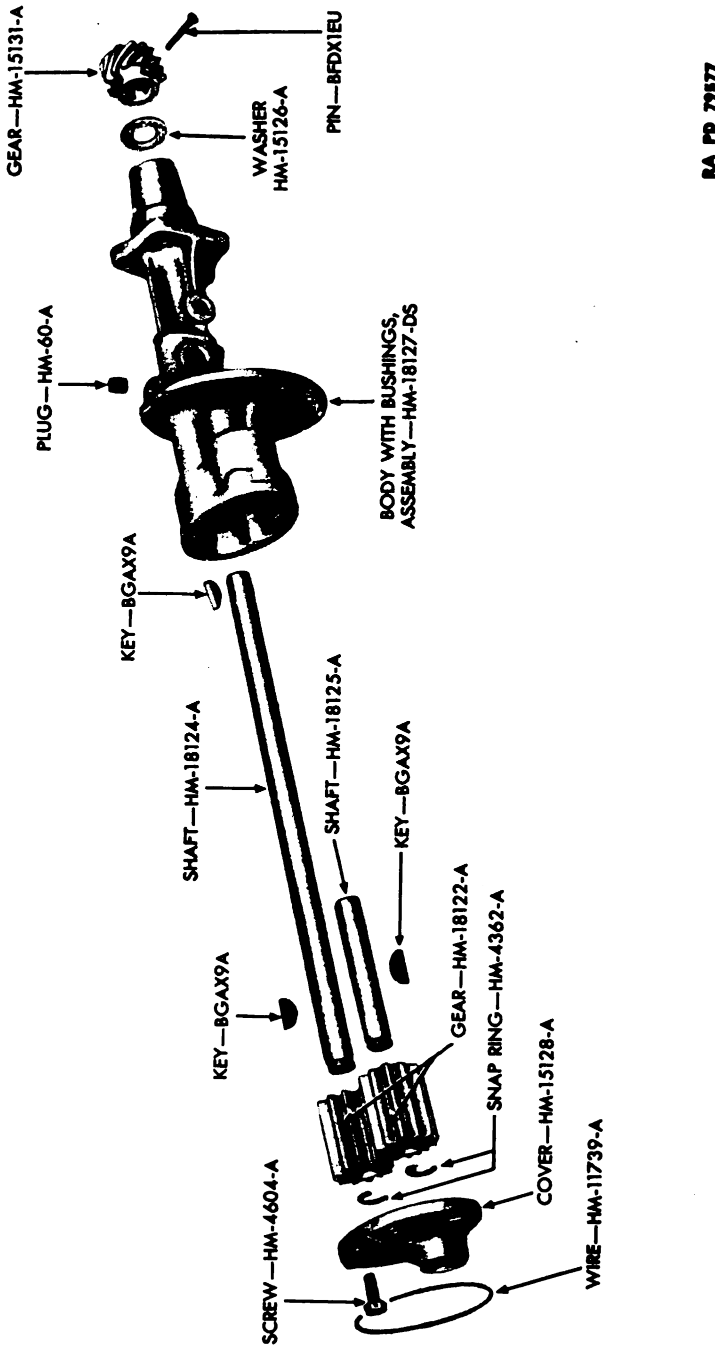


Figure 56—Oil Pump Disassembled

and shaft, and peen pin. Slide drive shaft into position in body. Tap key into keyway on lower end of shaft and tap spur gear onto key and shaft. Install snap ring on end of shaft.

(3) Tap key to seat in keyway in idler shaft. Insert shaft into its bushing within body. Tap spur gear on shaft and key. Install snap ring on end of shaft.

(4) Position cover on underside of body. Install screws which attach cover to body. Install safety wire through heads of screws.

(5) Position shell gasket and baffle shell on pump body. Install screws which attach shell to body. Install safety wire through heads of screws.

f. Installation (fig. 55).

(1) Place oil pump in position against machined surface on underside of cylinder block. Install the four lock washers and cap screws which attach pump to engine.

(2) Connect oil pipe to fitting in pump.

(3) Install oil pan (par. 72 **o** (3) and engine (par. 74 **b**).

Section VI

ENGINE ELECTRICAL SYSTEM—BATTERY CHARGING GENERATOR AND REGULATOR; ELECTRIC BRAKE RECEPTACLE

48. DESCRIPTION.

a. Generating Circuit (figs. 57 and 58). The entire battery charging generator circuit consists of a generator, regulator, ammeter, batteries, and connecting wires. The generator and regulator are covered in this section and ammeter in section II of chapter 6.

b. Two-charge Regulator (figs. 59 and 60).

(1) The two-charge regulator is a combination circuit breaker and voltage regulator. The circuit breaker automatically opens and closes the circuit between the generator and batteries. The voltage regulator adjusts generator output to correspond to the need of the batteries.

(2) The circuit breaker consists of an electromagnet and a set of contacts. The electromagnet has two windings. One winding is a shunt coil made of many windings and connected across the generator. The other winding is a series coil made of fewer turns of heavy wire.

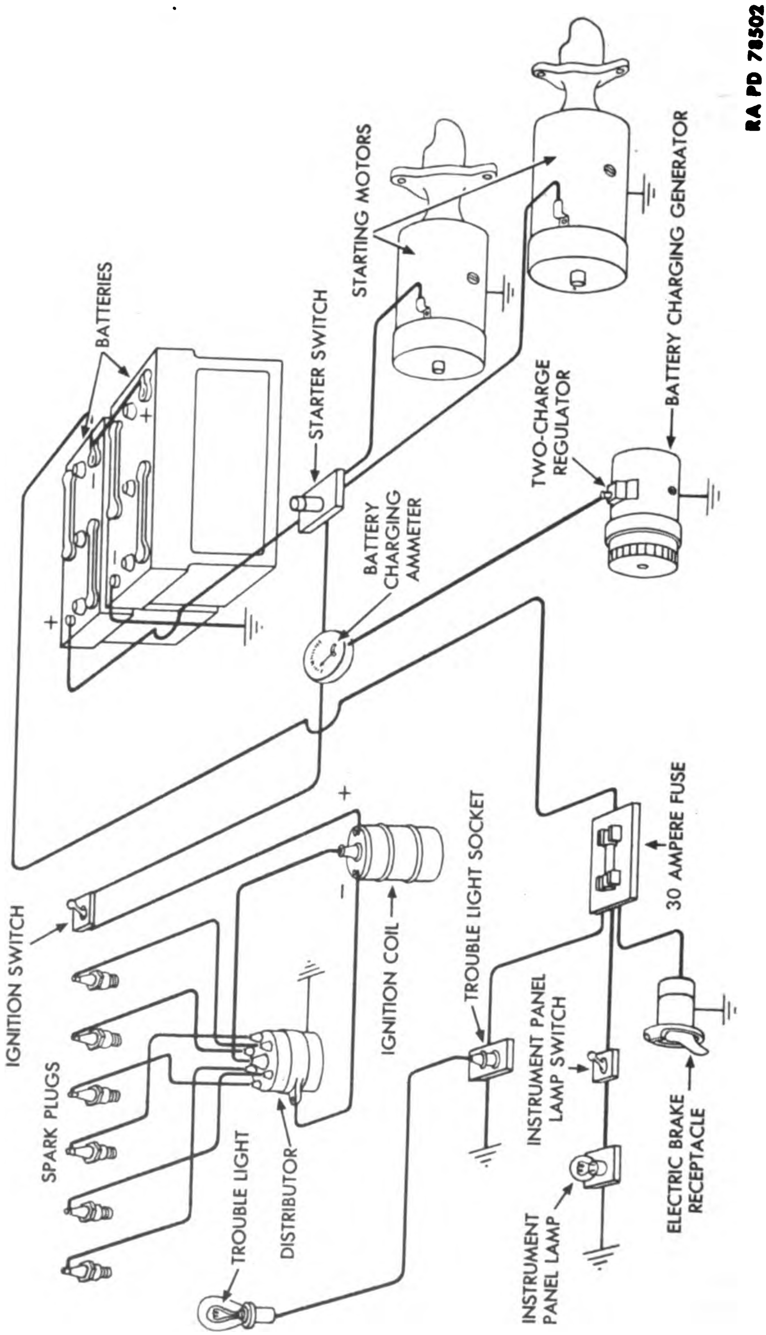


Figure 57—Engine Electrical System Diagram

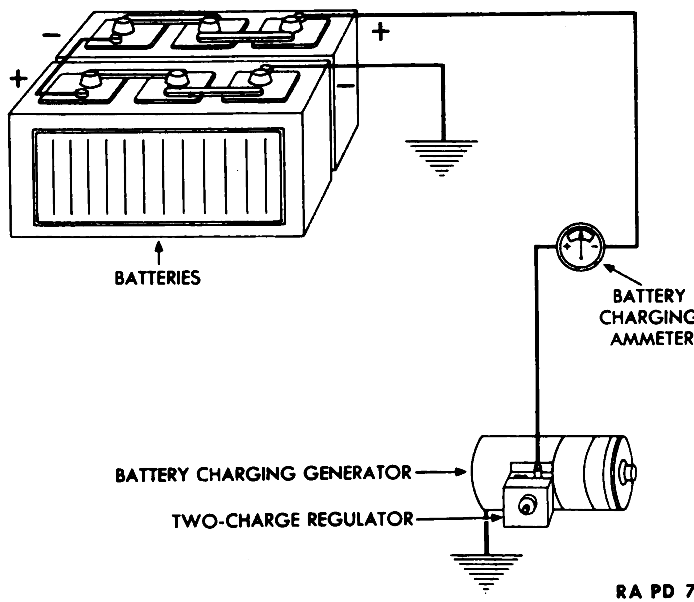


Figure 58—Battery Charging Generator Circuit

It is connected in series with generator output. The circuit breaker contacts consist of one movable contact mounted on an armature, operated by the electromagnet, while the other is a stationary contact. These contacts are held open by an armature spring when the engine is not running and at other times when battery voltage exceeds generator voltage. This prevents the battery from discharging through the generator. When the engine is started, the generator builds up voltage in the shunt coil. This activates the electromagnet and closes the generator-to-batteries circuit. The current from the generator to the batteries flows through the series coil. This coil also actuates the armature in the same direction as the shunt coil. The pull on the armature is increased, thus, and the contacts are held more tightly together. When the engine slows, the generator loses speed and the generator voltage drops. When it becomes less than the battery voltage, the current reverses. Then the magnetism created by the series coil is opposed to the diminished magnetism of the shunt coil. The magnetic pull is decreased, thus, and the spring again opens the contacts.

(3) The voltage regulator operates by inserting a resistance in the generator field circuit when the voltage reaches a predetermined value. The voltage regulator consists of an electromagnet, a set of

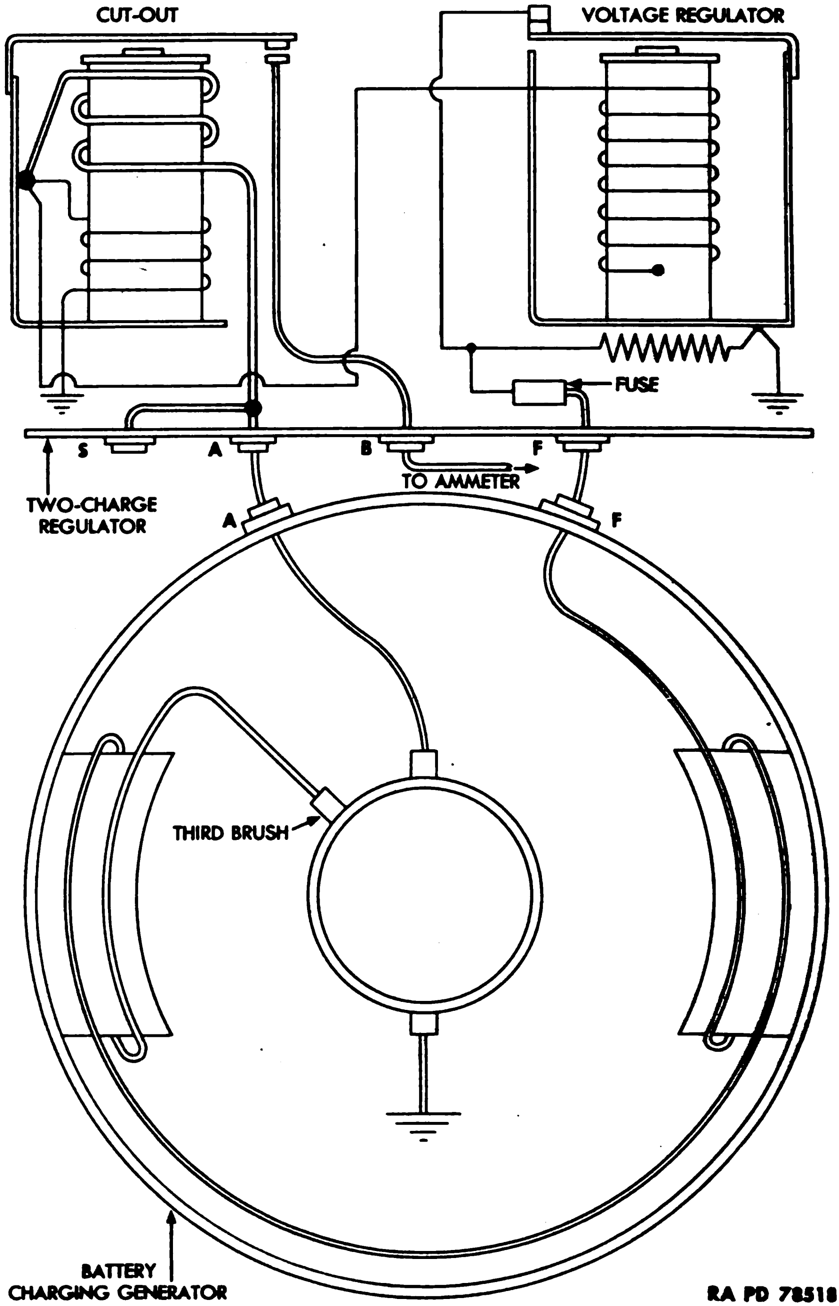


Figure 59—Battery Charging Generator and Regulator Wiring Diagram

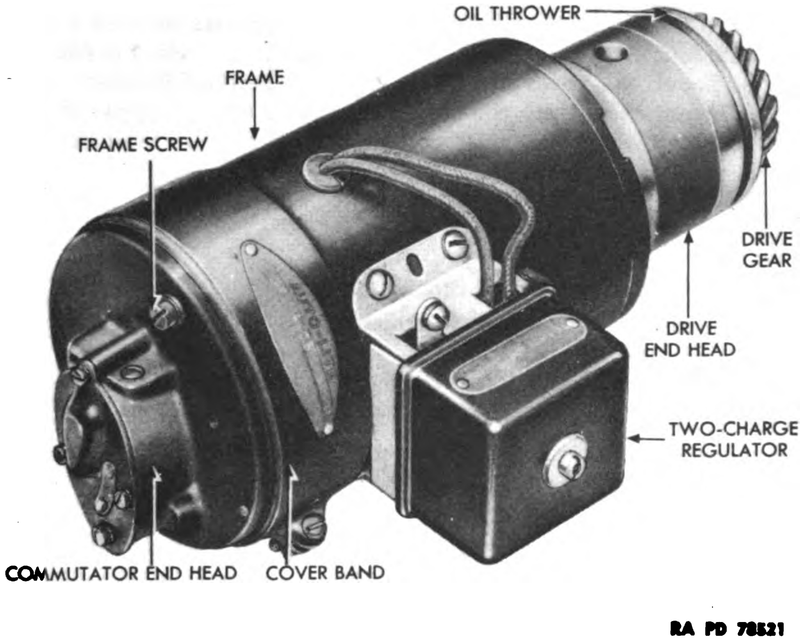


Figure 60—Battery Charging Generator and Two-charge Regulator Assembled

contacts, and a resistor. These parts are arranged so the contacts are normally closed, allowing the generator field circuit to pass through the contacts to ground. When the contacts are opened by action of the electromagnet, the generator field circuit must pass through the resistor to reach ground. The electromagnet is connected in the generator-to-batteries circuit. As the batteries reach full charge, the voltage in the circuit is built up. When the voltage reaches a point sufficient to operate the electromagnet, the points open. Another feature of the voltage regulator is the magnetic bypass which compensates for temperature changes. It consists of a small piece of nickel-iron across the top of the magnetic core of the electromagnet. The magnetic conductivity of this metal gradually increases as the temperature decreases. At low temperatures, consequently, much of the magnetic pull of the core, which would normally affect the cutting-in of the field resistance, flows through the bypass instead of the regular armature. This results in a higher generator voltage being required to cut in the field resistance.

c. **Electric Brake Receptacle** (figs. 1 and 79). The electric brake receptacle consists of a four-blade receptacle with a spring-loaded cover. The receptacle is of metal construction and is cylindrical in shape. It is attached perpendicularly to the rear side of

the left rear side panel by four screws. It encases an insert which holds the four blades in equally spaced grooves. Attached to the front side of panel, the cover assembly seals the receptacle when not in use. Current to operate the trailer electric brakes is transmitted to the receptacle through a wire connected to its "TL" terminal.

49. BATTERY CHARGING GENERATOR.

a. Disassembly.

(1) DISASSEMBLE INTO SUBASSEMBLIES (fig. 60).

(a) Loosen nut and screw which clamp cover band to frame. Slide cover band from frame.

(b) Loosen screws which attach field coil lead wires to brush holders. Remove lead wires from screws and remove brushes.

(c) Remove cotter pin and nut from end of armature shaft. Press drive gear from shaft. Tap key from shaft and slide oil thrower from shaft.

(d) Remove the two frame screws. Tap commutator end head. Remove head with brush assemblies from frame.

(e) Tap drive end head to loosen head from frame. Lift head and armature from frame. Press armature from drive end head.

(2) DISASSEMBLE COMMUTATOR END HEAD (fig. 70).

(a) Remove the four screws and lock washers which attach wick cover to head. Lift cover, gasket, and wick from head.

(b) Remove screw and lock washer which attach each of the three brush leads to its brush holder. Slide brushes from holders. Unclip springs and slide arms and springs from brush holder studs.

(c) Remove the two screws and lock washers which secure grounded brush holder to head.

(d) Take out screw which holds Y-spring to head. Lift spring and adjustable third brush holder plate from head.

(e) Pull guard and gasket from inside of head. Press bronze bearing from head.

(3) DISASSEMBLE FRAME (fig. 69). NOTE: *Test field coils (subpar.* b (1) *below). If tests are satisfactory and coils are in good condition, disassembly of frame is not necessary.*

(a) Pull wire leads through rubber bushing (grommet) into frame. Remove bushing from frame.

(b) Unscrew and remove the two pole piece screws (fig. 69).

(c) From inside frame, remove the two pole pieces, two field coils, and one piece of insulation.

(4) DISASSEMBLE DRIVE END HEAD (fig. 68).

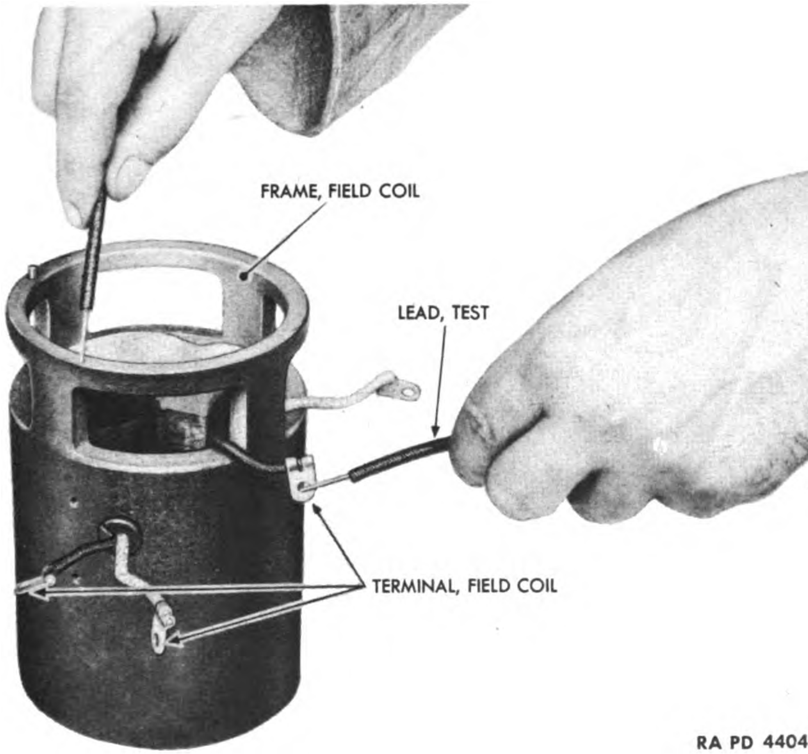


Figure 61—Field Coil Test for Ground

(a) Remove the three screws and lock washers which secure the bearing retainer to outside of head. Lift retainer from head.

(b) Press bearing from head.

b. Inspection.

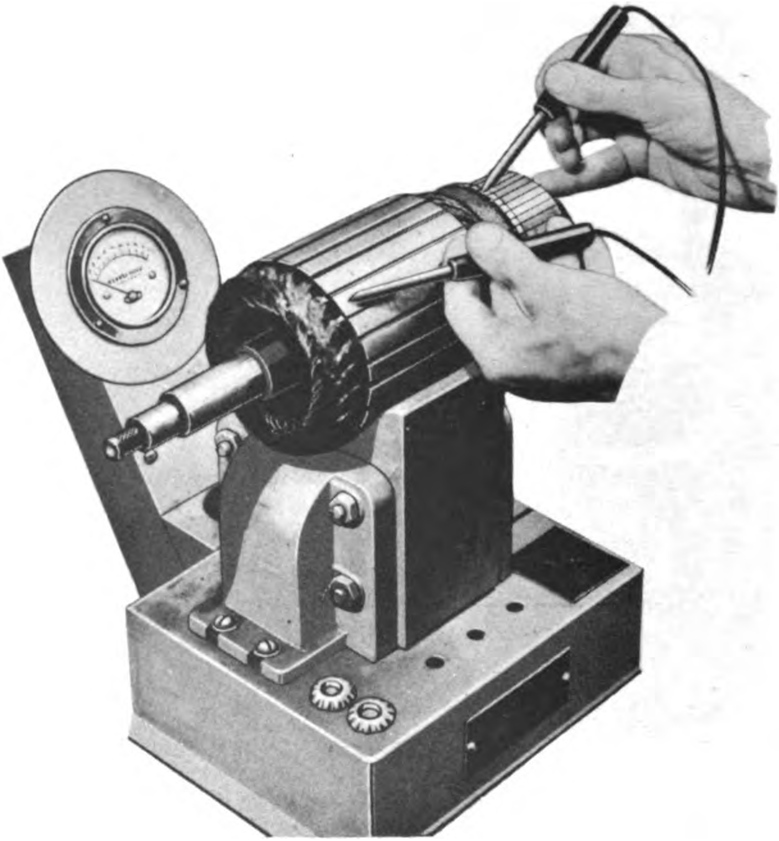
(1) FIELD COILS.

(a) Place test prods of a test lamp on terminals at ends of two leads of a field coil. If test lamp fails to light, an open circuit is indicated. Repeat test on other field coil.

(b) Connect a field coil, battery, and ammeter in series, and note ammeter reading. Repeat test on other field coil. If one coil draws more current than the other, an internal short is indicated in the coil which consumes most current.

(2) ARMATURE.

(a) Place one test prod of a test lamp on armature shaft or core



RA PD 318012

Figure 62—Testing Armature for Grounded Circuit

and the other prod on each commutator bar in turn. If test lamp lights on any of the tests, armature is grounded (fig. 62).

(b) Place armature in a growler. With hacksaw blade over core, rotate armature and test. If saw blade vibrates, a shorted armature is indicted. Clean out all dirt from between commutator bars and repeat test. If short persists, it is in the coils, and armature must be replaced (fig. 63).

(c) Touch probes of a test lamp to each pair of adjacent commutator bars. If lamp fails to light on any test, an open circuit is indicated.

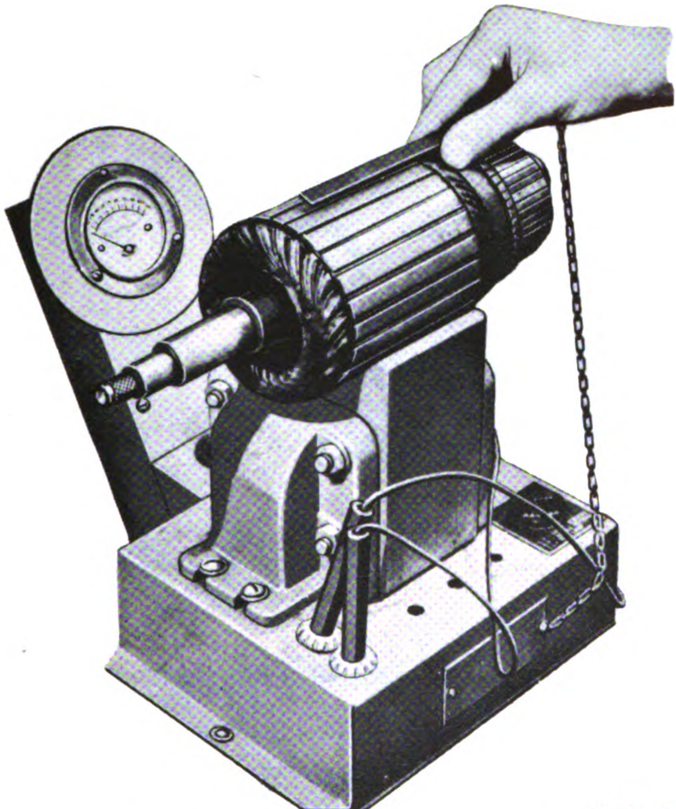


Figure 63—Testing Armature for Shorted Circuit

(d) Check commutator for roughness and high mica. Check armature coil to commutator bar lead wires to see that each is properly soldered to commutator bar. Place armature in V-blocks, mount dial indicator with plunger against commutator, rotate armature, and note reading on indicator. If reading varies 0.0005 inch or more, commutator is out-of-round (fig. 64).

(3) MISCELLANEOUS.

(a) Check fit of armature shaft in commutator end bearing. If fit is loose enough to permit noticeable side play, bearing is worn out.

(b) Clean drive end bearing in dry-cleaning solvent, and dry with compressed air. Do not allow air to spin bearing. Check bearing to see if either race or any ball is worn, chipped, scored, or broken. Rotate bearing slowly and listen for grinding noise which indicates unserviceable bearing.

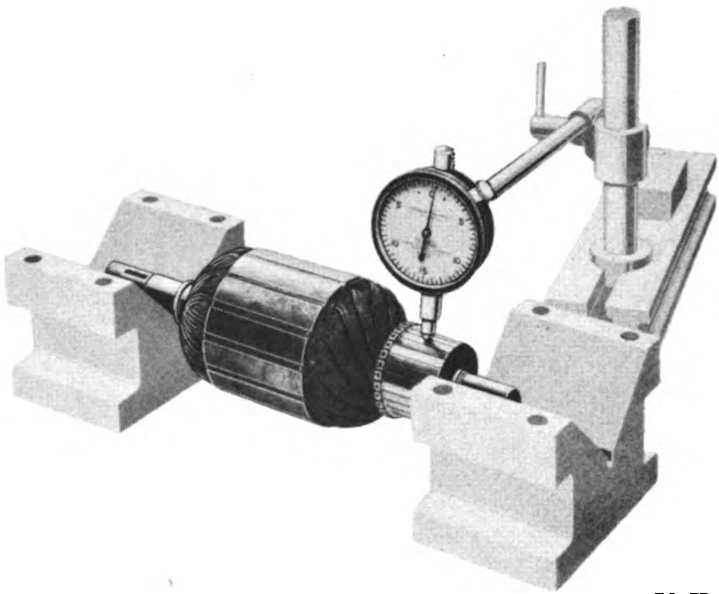


Figure 64—Measuring Commutator for Out-of-round

(c) Check tension of brush springs with spring scale hooked under brush (fig. 65). Fifteen to twenty ounces tension are required to hold new brush snugly against commutator.

(d) Check brushes to see if they are broken. Note amount of wear. They are worn out if no longer at least half their new length.

c. **Repair.**

(1) Replace generator assembly if unrepairable.

(2) Turn down rough or out-of-round commutator in a lathe. Dress bars with class B flint paper, No. 2/0. Undercut the mica (figs. 66 and 67) and again check armature in growler for short circuit.

d. **Assembly.**

(1) ASSEMBLE DRIVE END HEAD (fig. 68).

(a) Pack drive end bearing with lubricating grease (special) and press into drive end head.

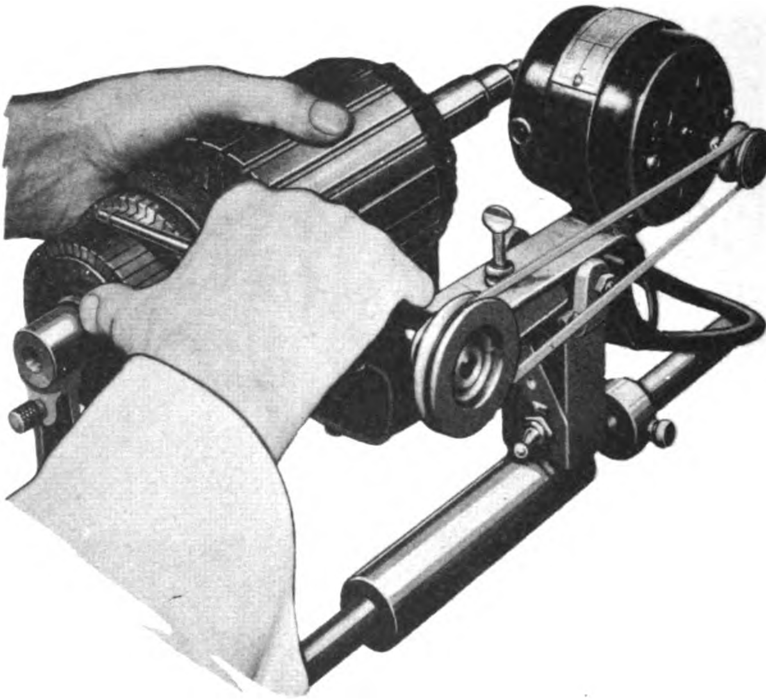
(b) Position retainer over bearing on outside of head. Install the three lock washers and screws which attach retainer to head.

Figure 65—Measuring Brush Spring Tension

(2) ASSEMBLE FRAME (fig. 69).

(a) Place insulation in position inside frame. It may be held in place with glue.

(b) Solder together the leads without lugs from the two field coils. Attach coils to inside of frame by inserting a pole piece within each coil, and securing pole pieces to frame with pole piece screws. Tighten screws securely. Bring the single unattached wire from one field coil up through frame bushing hole on top of frame. Carry one of the ends of the gray wire taped to the other field coil up through the same hole. Install rubber bushing around the wires in bushing hole.



RA PD 315019

Figure 66—Undercutting Commutator Mica With Undercutter

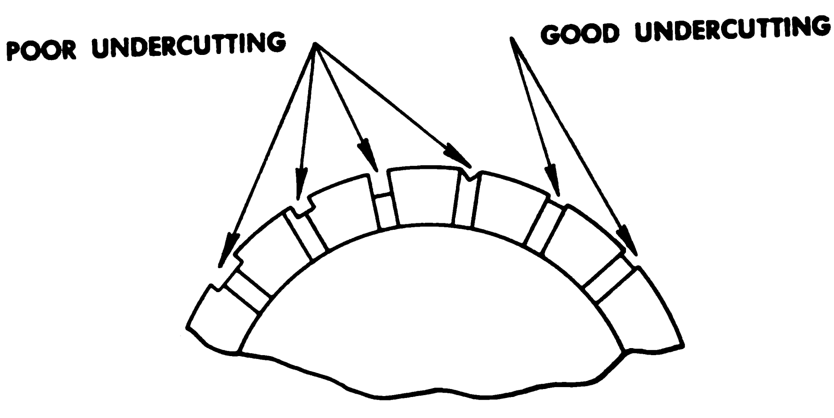


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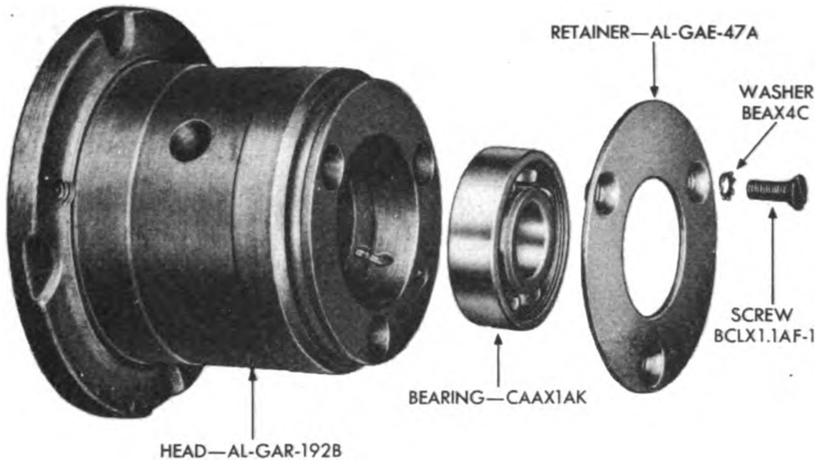
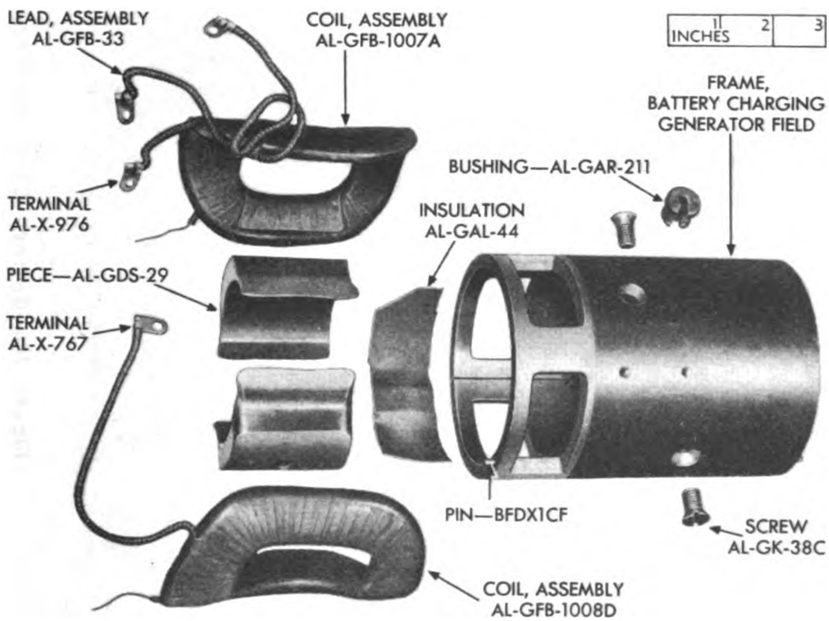
Figure 67—Examples of Good and Poor Undercutting



RA PD 78406

Figure 68—Battery Charging Generator Drive End Head Disassembly



RA PD 78407

Figure 69—Battery Charging Generator Frame Disassembled

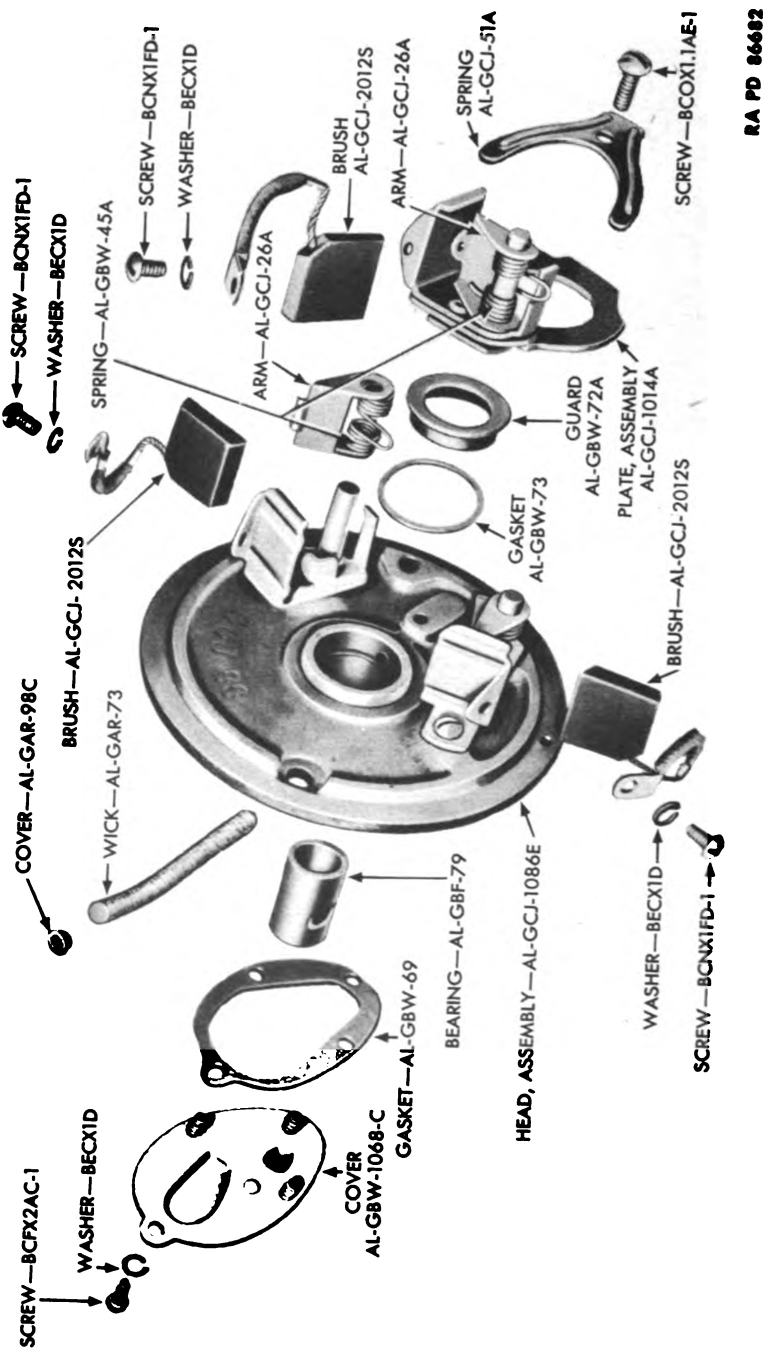


Figure 70—Battery Charging Generator Commutator End Head

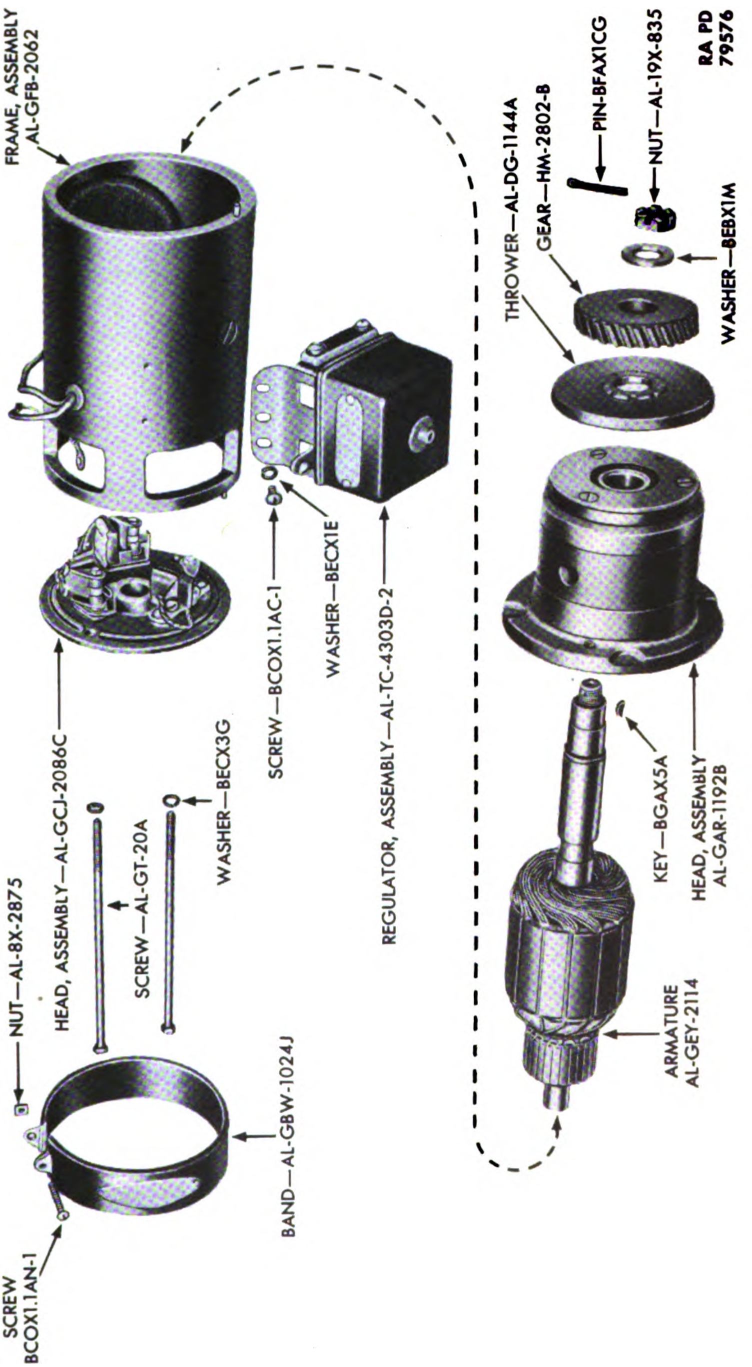


Figure 71—Battery Charging Generator Disassembled

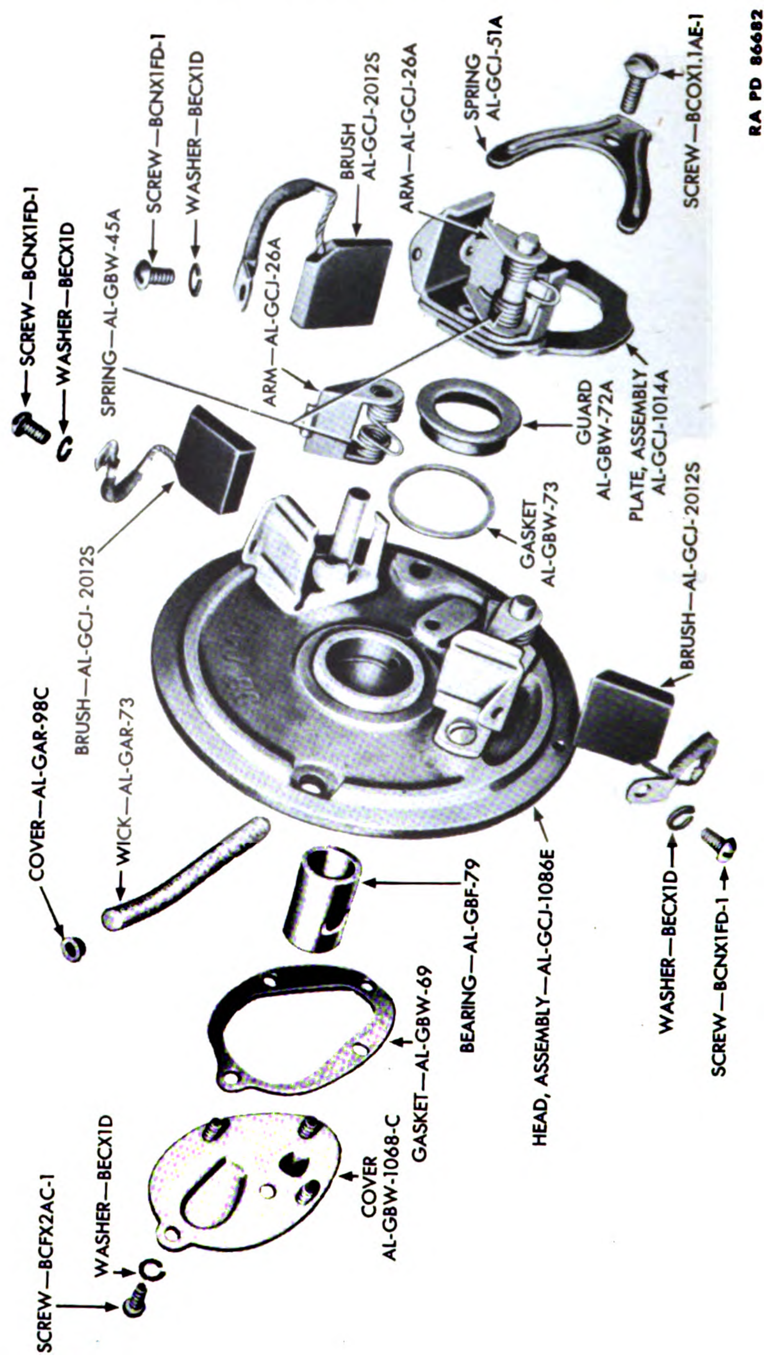


Figure 70—Battery Charging Generator Commutator End Head

ENGINE AND ACCESSORIES

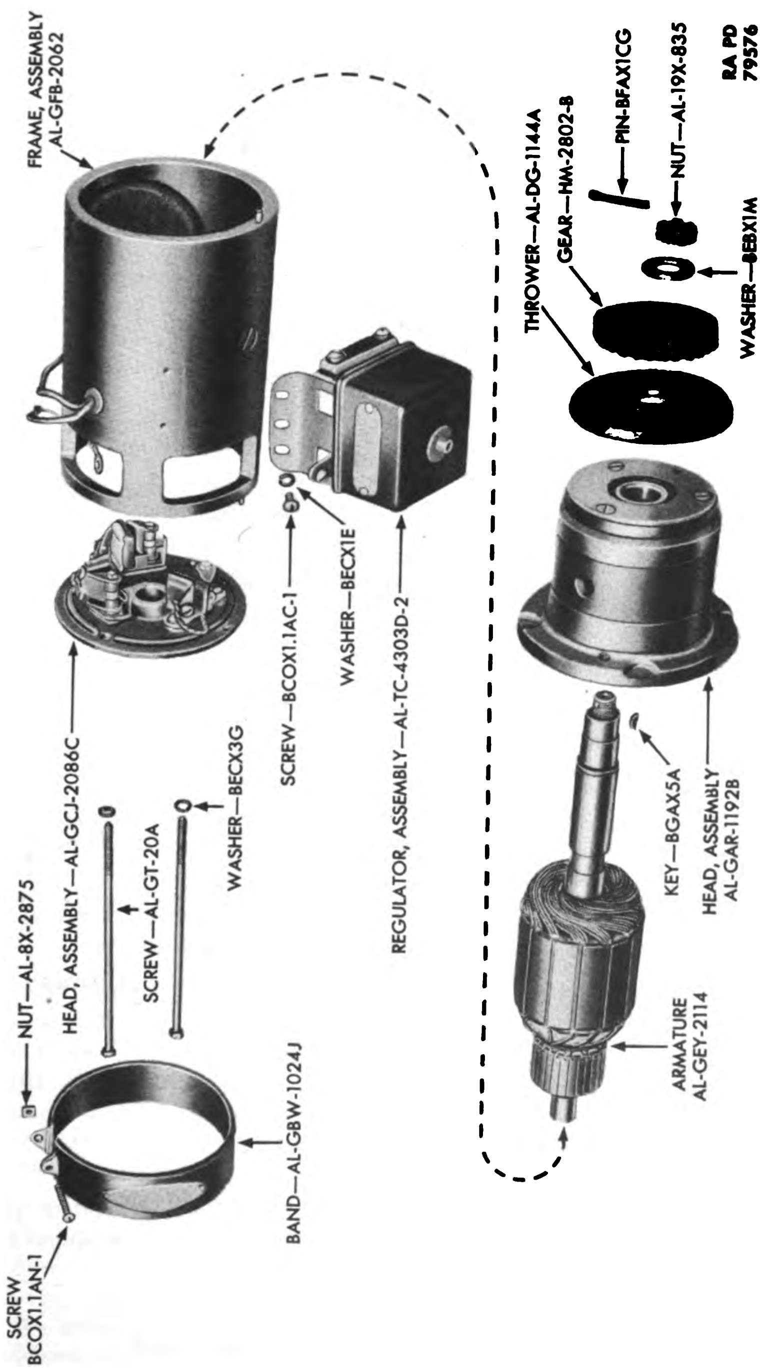
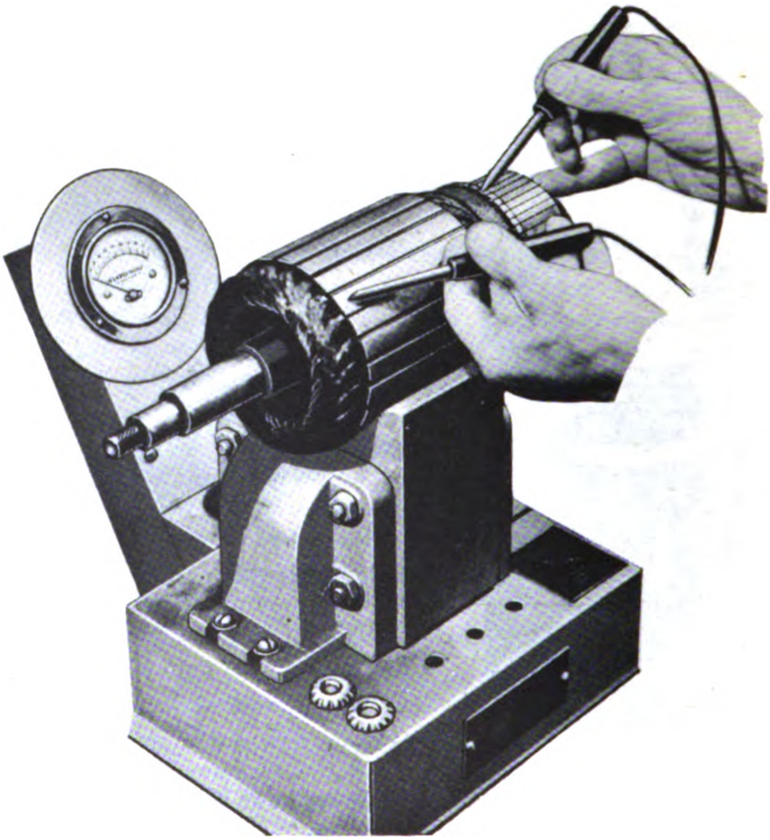


Figure 71—Battery Charging Generator Disassembled



RA PD 315012

Figure 62—Testing Armature for Grounded Circuit

and the other prod on each commutator bar in turn. If test lamp lights on any of the tests, armature is grounded (fig. 62).

(b) Place armature in a growler. With hacksaw blade over core, rotate armature and test. If saw blade vibrates, a shorted armature is indicted. Clean out all dirt from between commutator bars and repeat test. If short persists, it is in the coils, and armature must be replaced (fig. 63).

(c) Touch probes of a test lamp to each pair of adjacent commutator bars. If lamp fails to light on any test, an open circuit is indicated.

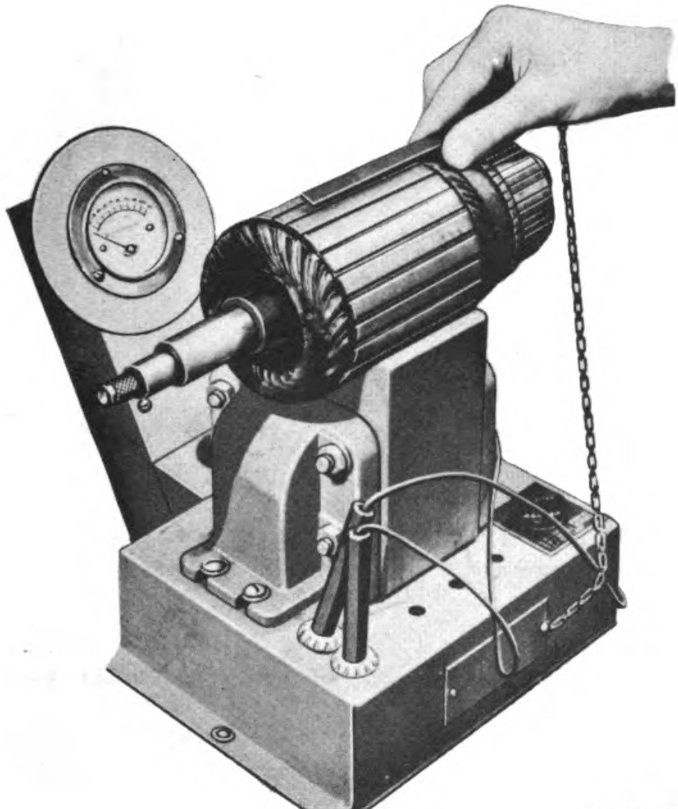

RA PD 315013

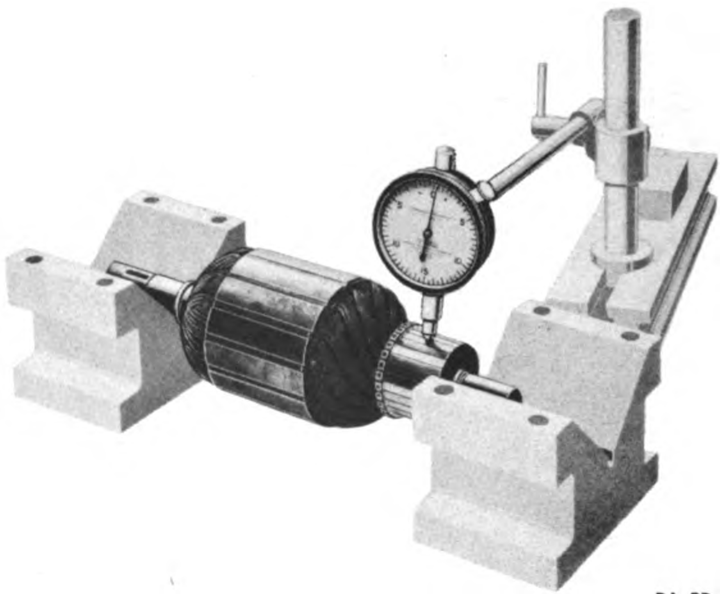
Figure 63—Testing Armature for Shorted Circuit

(d) Check commutator for roughness and high mica. Check armature coil to commutator bar lead wires to see that each is properly soldered to commutator bar. Place armature in V-blocks, mount dial indicator with plunger against commutator, rotate armature, and note reading on indicator. If reading varies 0.0005 inch or more, commutator is out-of-round (fig. 64).

(3) MISCELLANEOUS.

(a) Check fit of armature shaft in commutator end bearing. If fit is loose enough to permit noticeable side play, bearing is worn out.

(b) Clean drive end bearing in dry-cleaning solvent, and dry with compressed air. Do not allow air to spin bearing. Check bearing to see if either race or any ball is worn, chipped, scored, or broken. Rotate bearing slowly and listen for grinding noise which indicates unserviceable bearing.



RA PD 315014

Figure 64—Measuring Commutator for Out-of-round

(c) Check tension of brush springs with spring scale hooked under brush (fig. 65). Fifteen to twenty ounces tension are required to hold new brush snugly against commutator.

(d) Check brushes to see if they are broken. Note amount of wear. They are worn out if no longer at least half their new length.

c. **Repair.**

(1) Replace generator assembly if unrepairable.

(2) Turn down rough or out-of-round commutator in a lathe. Dress bars with class B flint paper, No. 2/0. Undercut the mica (figs. 66 and 67) and again check armature in growler for short circuit.

d. **Assembly.**

(1) ASSEMBLE DRIVE END HEAD (fig. 68).

(a) Pack drive end bearing with lubricating grease (special) and press into drive end head.

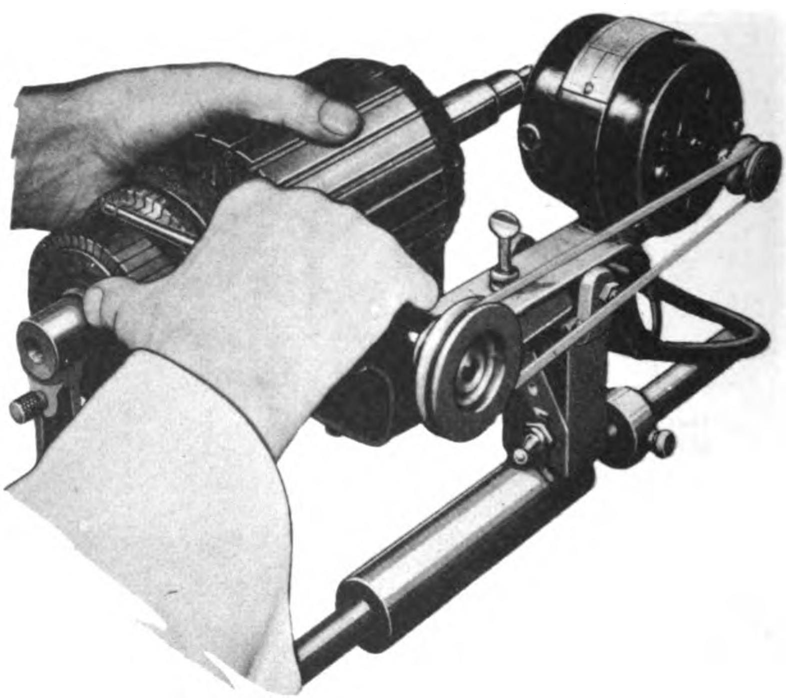
(b) Position retainer over bearing on outside of head. Install the three lock washers and screws which attach retainer to head.

Figure 65—Measuring Brush Spring Tension

(2) ASSEMBLE FRAME (fig. 69).

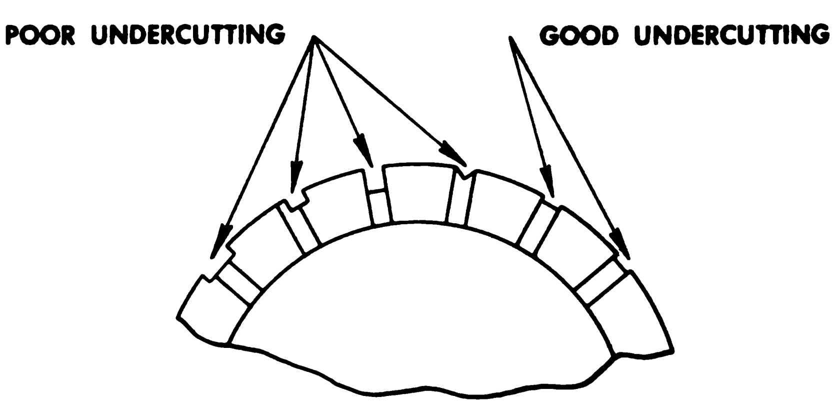
(a) Place insulation in position inside frame. It may be held in place with glue.

(b) Solder together the leads without lugs from the two field coils. Attach coils to inside of frame by inserting a pole piece within each coil, and securing pole pieces to frame with pole piece screws. Tighten screws securely. Bring the single unattached wire from one field coil up through frame bushing hole on top of frame. Carry one of the ends of the gray wire taped to the other field coil up through the same hole. Install rubber bushing around the wires in bushing hole.



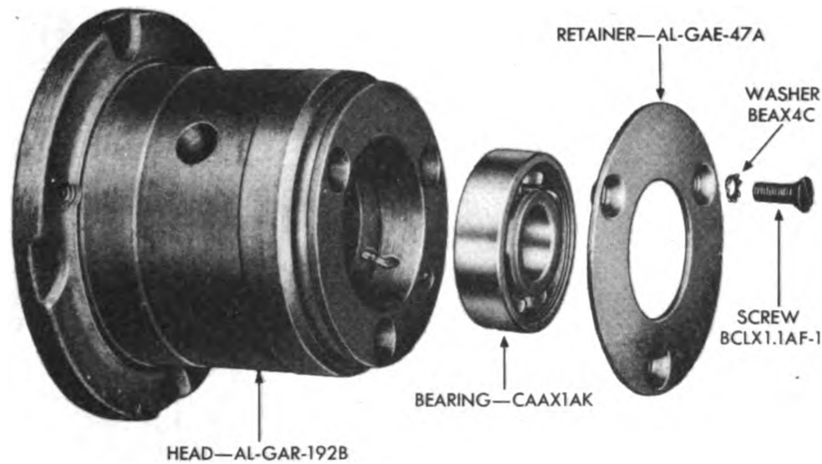
RA PD 315819

Figure 66—Undercutting Commutator Mica With Undercutter



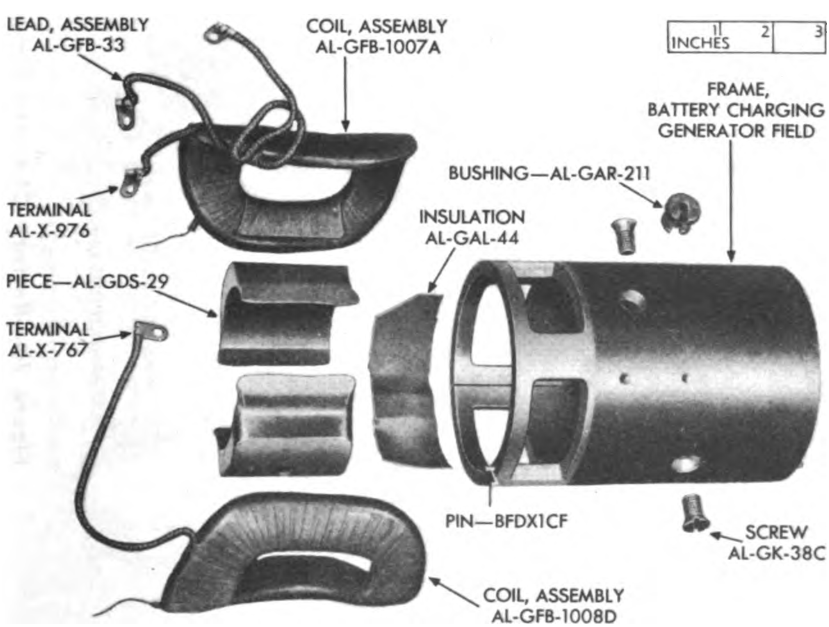
RA PD 315820

Figure 67—Examples of Good and Poor Undercutting



RA PD 78406

Figure 68—Battery Charging Generator Drive End Head Disassembly



RA PD 78407

Figure 69—Battery Charging Generator Frame Disassembled

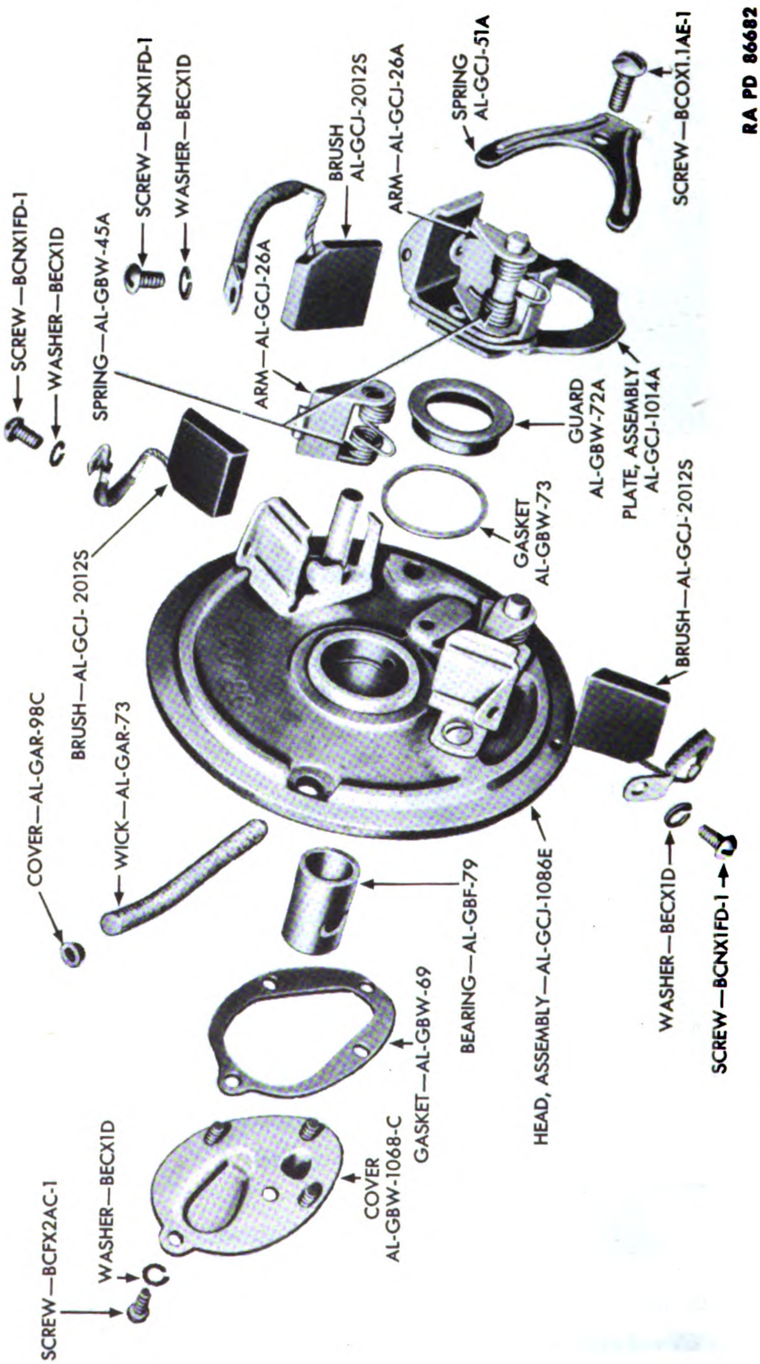


Figure 70—Battery Charging Generator Commutator End Head

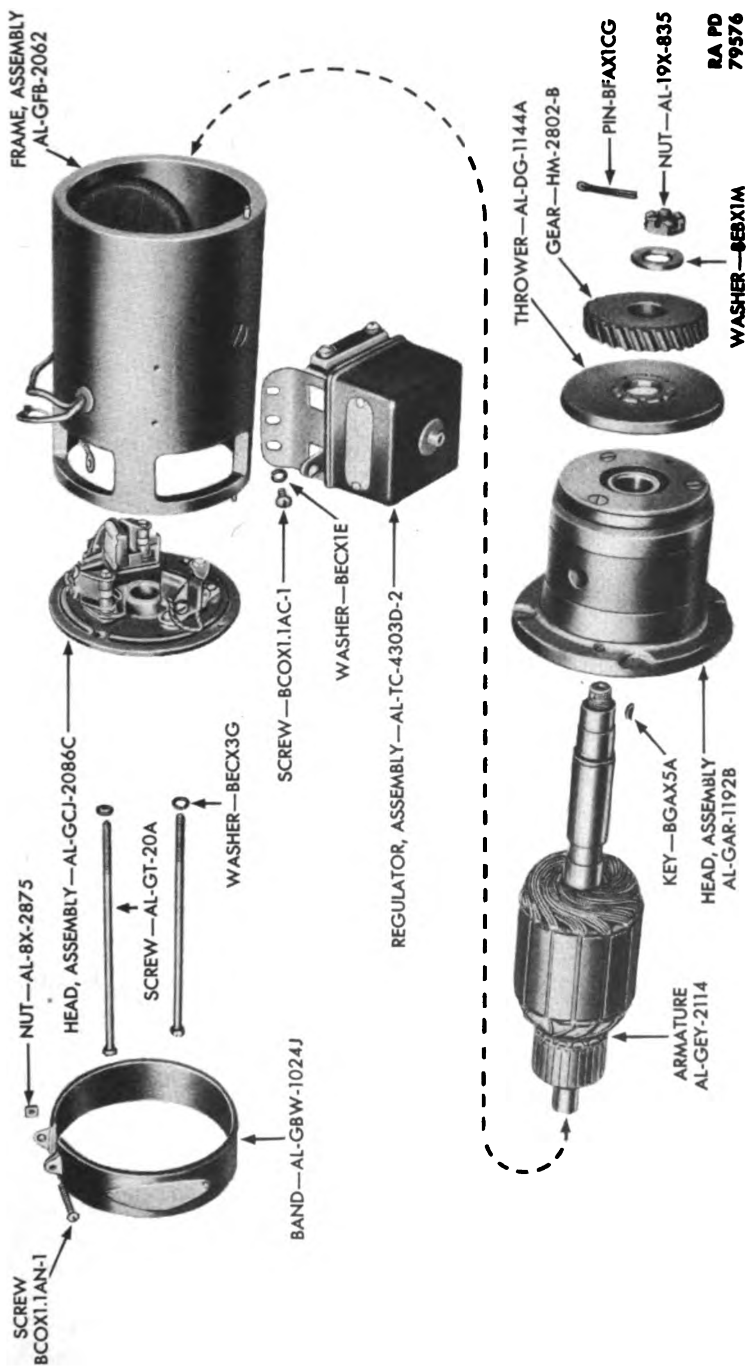


Figure 71—Battery Charging Generator Disassembled

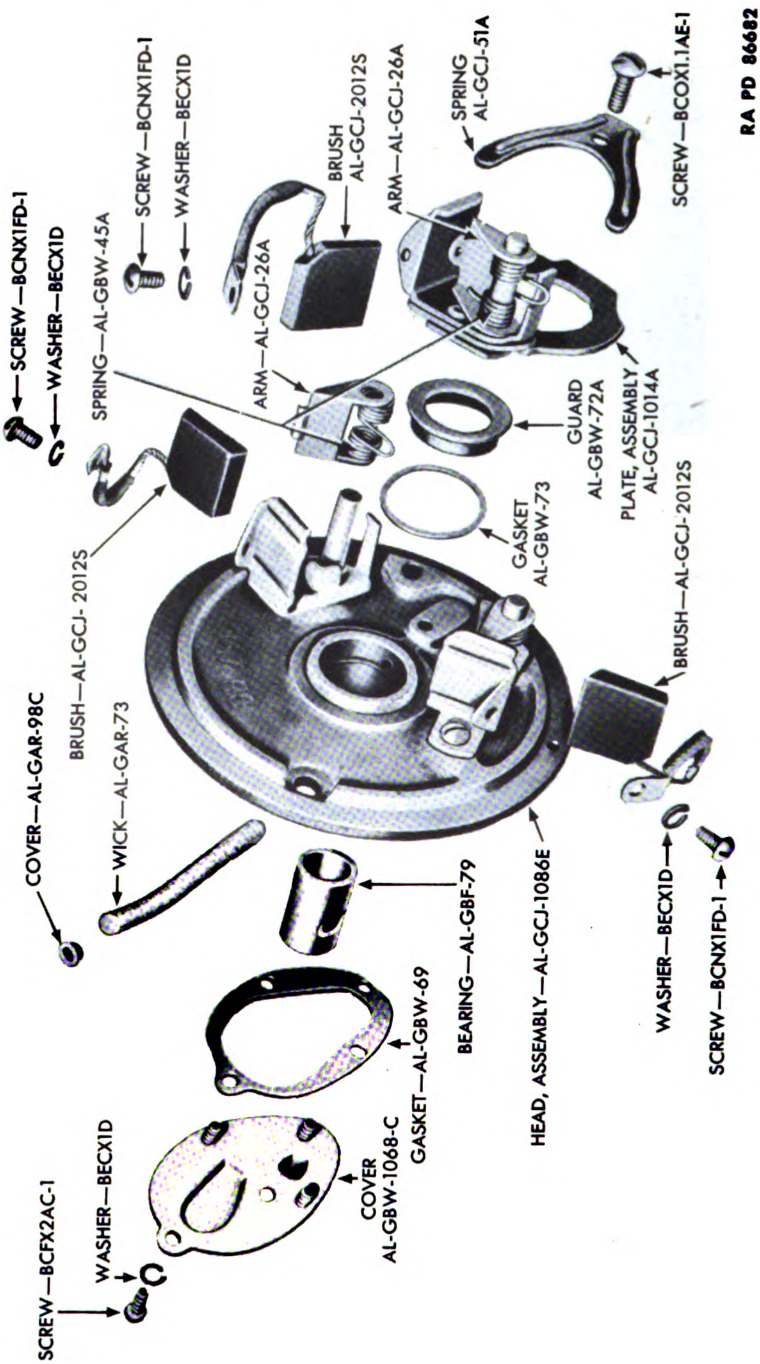


Figure 70—Battery Charging Generator Commutator End Head

ENGINE AND ACCESSORIES

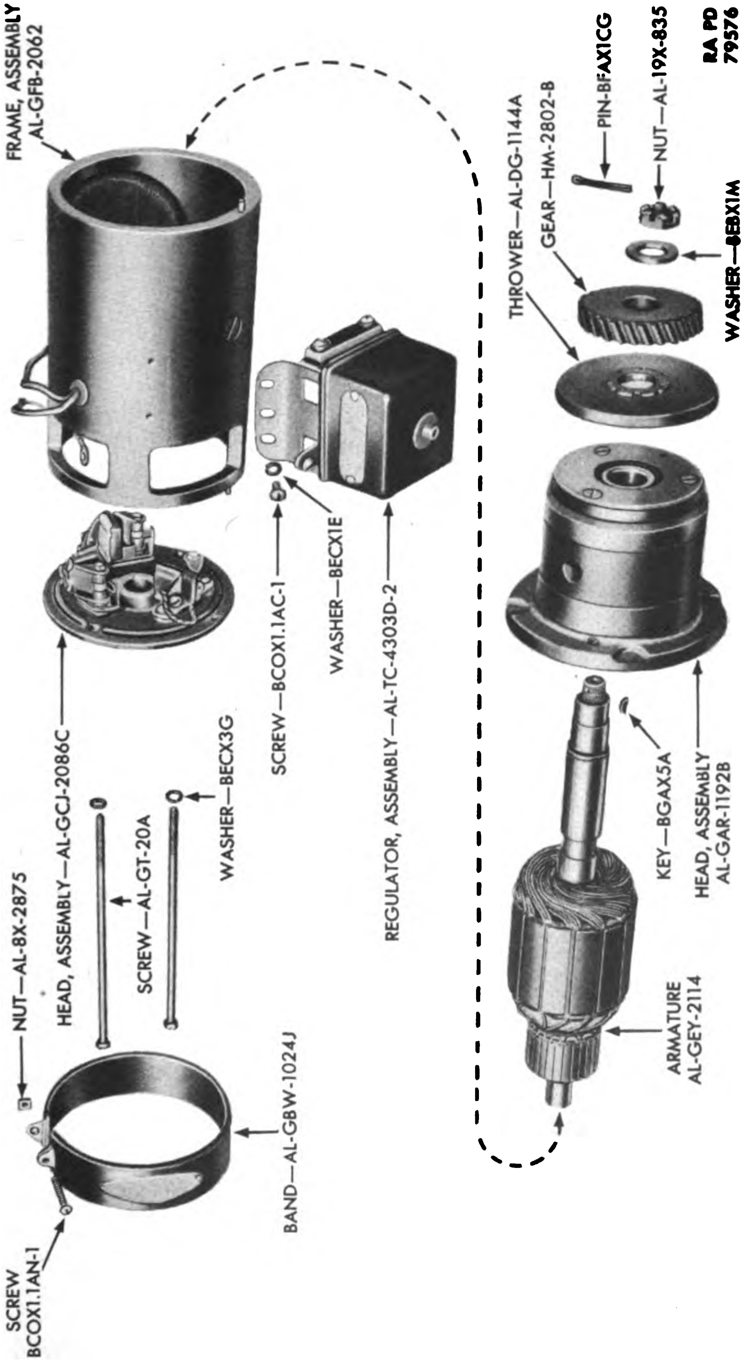


Figure 71—Battery Charging Generator Disassembled

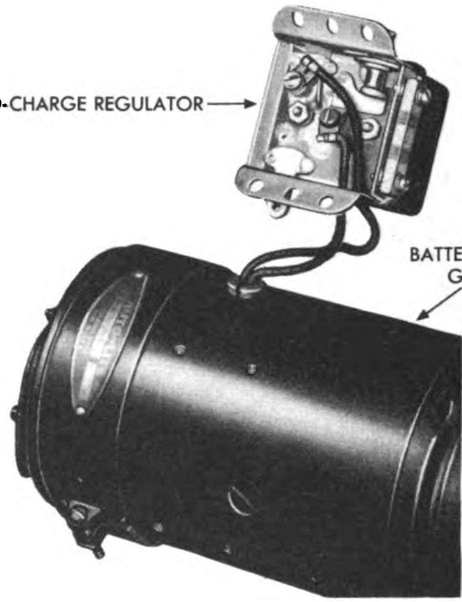


Figure 72—Two-charge Regulator Showing Generator Connections

(3) ASSEMBLE COMMUTATOR END HEAD (fig. 70).

(a) Aline oil wick holes in bronze bearing and head. Press bearing into position in head. Position gasket and guard on inside of head and tap to seat.

(b) Position adjustable third brush holder plate and Y-spring on inside of head. Install screw which secures spring to head.

(c) Position grounded brush holder on inside of head. Install the two lock washers and screws which attach holder to head.

(d) Position spring in arm and slide into place on brush holder stud. Repeat process to install two remaining arms and springs. Insert brushes into holders just far enough so arms hold them rigid. Connect each brush lead to its holder with lock washer and screw provided for purpose.

(e) On outside of head, install wick (saturated with oil as prescribed by WDLO), cover gasket, wick cover, four lock washers, and four screws respectively.

(4) ASSEMBLE SUBASSEMBLIES (fig. 71).

(a) Press armature into bearing in drive end head.

(b) Insert armature into frame from drive end. Aline dowel in frame with dowel hole in drive end head. Tap head to seat on frame.

(c) Position commutator end head on frame, alining dowel on frame with dowel hole in head. Tap head to seat on frame. Install the two frame screws.

(d) Attach field coil lead wires to brush holders as follows: black field lead to adjustable third brush holder, gray armature lead to stationary brush holder insulated from head. Use same washer and screw which attach brush leads to attach these wires.

(e) Slide cover band into position over brush access holes in frame, and tighten bolt into nut.

(f) Tap thrower into position on end of armature shaft. Tap key into keyway and press drive gear onto shaft and key. Install nut and cotter pin on end of drive shaft.

50. TWO-CHARGE REGULATOR.

a. Removal (fig. 72).

(1) Disconnect "CG" wire from terminal on top side of regulator.

(2) Remove the four screws and lock washers which attach regulator to generator.

(3) Disconnect red field lead wire from "F" terminal, and gray armature lead wire from "A" terminal. These terminals are both on attaching side of regulator.

(4) Lift regulator from generator.

b. Disassembly (fig. 78).

(1) Remove cover nut and lift cover from regulator.

(2) Remove the two screws, lock washers, and flat washers which attach resistor to side of base. Lift resistor and two flat washers from base.

(3) Unscrew retainer and remove fuse and insulation from base.

(4) Unclip circuit breaker armature spring from hooks on armature and frame. Similarly remove voltage regulator spring.

c. Inspection and Repair.

(1) Examine for evidence of burning or abnormally high temperatures at the coils, contacts, insulation, external terminals, or other points.

(2) Examine for loose connections resulting from poor soldering.

(3) Examine for loose nuts on bottom of magnet cores, loose rivets, or screws. All nuts and screws must have lock washers.

(4) CONTACTS. Clean all contacts by filing, parallel with length of the armature, with a very fine file so that they are free from pits and burning. Clean points with carbon tetrachloride to remove any

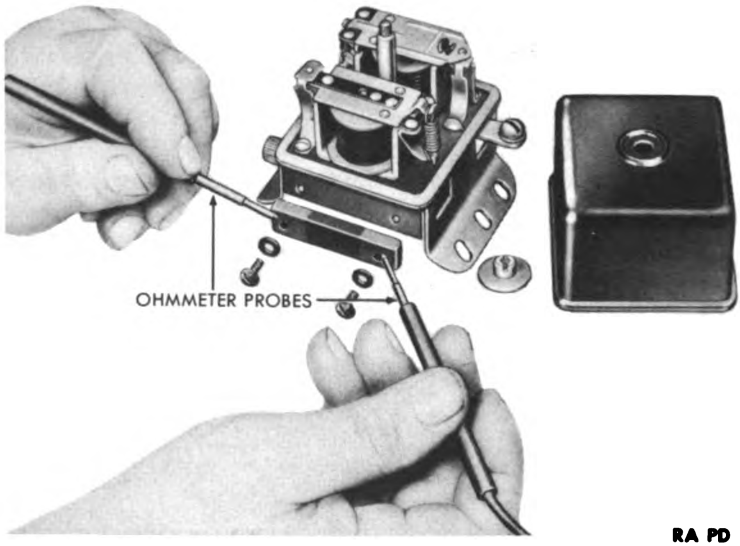


Figure 73—Testing Regulator Carbon Resistor

dirt or grease. Pull a piece of clean cloth between contacts to remove any residue.

(5) CARBON RESISTOR (fig. 73). Check resistance of the carbon resistor with an ohmmeter. It must read 11 ohms, plus or minus 5 percent.

(6) CIRCUIT BREAKER ARMATURE AIR GAP. Check circuit breaker armature air gap. This check is made with contacts closed, and is adjusted by raising or lowering stationary contact. Adjust to 0.010 to 0.030 inch.

(7) CIRCUIT BREAKER CONTACT GAP (fig. 74). Check circuit breaker contact gap. It must be 0.015 to 0.045 inch. Adjust by bending armature stop.

(8) REGULATOR ARMATURE AIR GAP (fig. 75). Check regulator armature air gap. It must be 0.044 to 0.046 inch. Measure gap with regulator contact closed. Adjust by raising or lowering upper contact by expanding or contracting the bridge holding upper contact.

(9) CHECK REGULATOR CONTACT GAP. Check regulator contact gap; it must have 0.005-inch minimum gap. Adjust by bending brass cam.

(10) TEST AND ADJUST CIRCUIT BREAKER OPERATION. Connect a voltmeter as shown in figure 86. Increase the voltage from zero and note voltage at which points close as indicated by lamp lighting. Points should close between 13.0 and 13.5 volts. Adjust, if necessary,

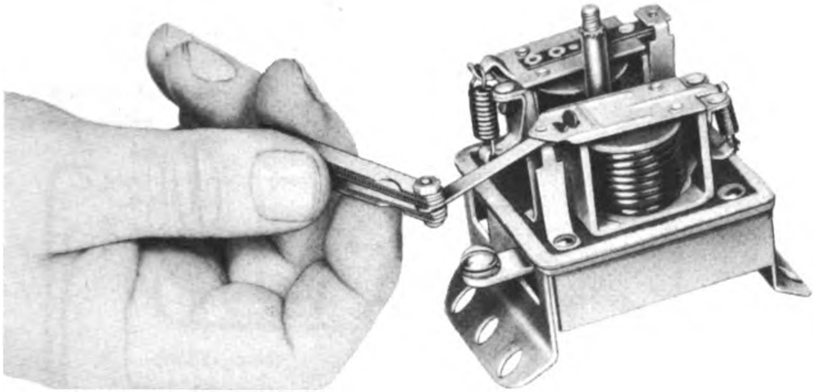


Figure 74—Checking Circuit Breaker Contact Gap

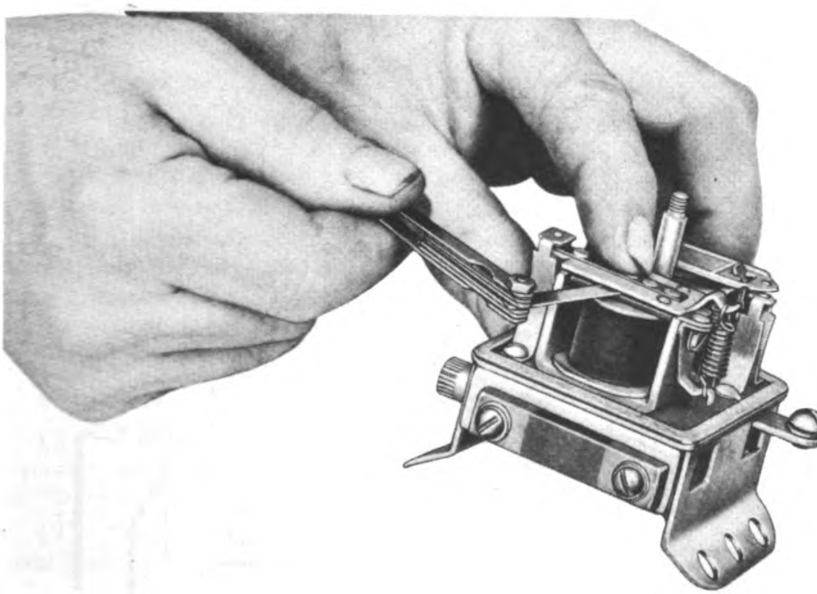


Figure 75—Checking Regulator Armature Gap

by increasing or decreasing tension of circuit breaker armature spring. This is done by bending hanger at bottom of spring.

(11) Test and Adjust Regulator Operation. Connect a voltmeter as shown in figure 77. Increase the voltage from zero and

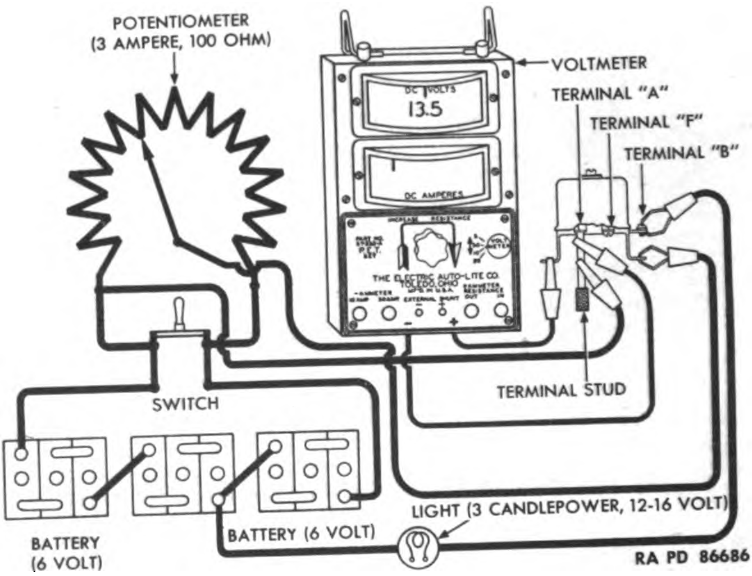


Figure 76—Testing Circuit Breaker Operation

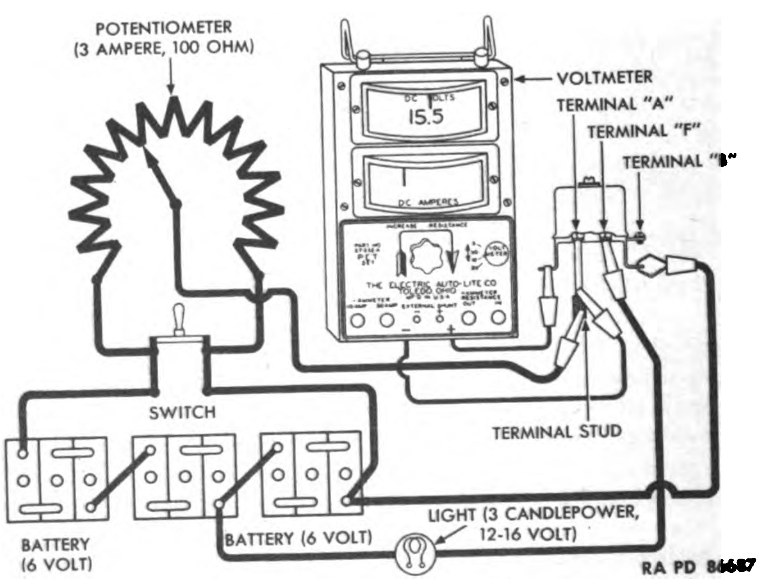


Figure 77—Testing Regulator Operation

notice voltage at which contacts open. This is indicated by the lamps becoming dim or going out. Reduce the voltage and note reading when contacts open as indicated by brightening or lighting of lamp. If necessary, alter tension of regulator armature spring to bring opening and closing voltages within range indicated by following table:

Temperature (Degrees Fahrenheit)	High-to-low Charge (Volts)
50	15.95 ± 0.20
60	15.80 ± 0.20
70	15.65 ± 0.20
80	15.50 ± 0.20
90	15.35 ± 0.20
100	15.20 ± 0.20
110	15.05 ± 0.20

NOTE: *When generator changes from low charge rate to high charge rate, the voltage is 2.0 to 2.4 volts lower than when it changes from high charge rate to low charge rate.*

d. **Assembly** (fig. 78).

(1) Hook circuit breaker armature spring AL-CB-123 to hooks on circuit breaker armature and frame. Similarly install voltage regulator spring AL-IG-863 on voltage regulator.

(2) Insert insulation and fuse into socket in base of regulator and install retainer.

(3) On base of regulator, position two fibre washers, one resistor, two flat washers, and two lock washers. Install the two screws which attach these parts.

(4) Position cover on regulator and install cover nut.

e. **Installation** (fig. 72).

(1) Connect generator armature lead wire (gray) to "A" terminal on attaching side of regulator. Connect generator field lead wire (red) to "F" terminal.

(2) Position regulator on generator (fuse down) and install the four lock washers and screws which hold regulator to generator.

(3) Connect "CG" wire to terminal on top of regulator.

51. ELECTRIC BRAKE RECEPTACLE.

a. **General.** The electric brake receptacle consists of a four-blade receptacle with a spring-loaded cover. The receptacle is of metal construction and is cylindrical in shape. It is attached perpendicularly to the rear side of the left rear panel by four screws. It encases an insert which holds the four blades in equally spaced grooves.

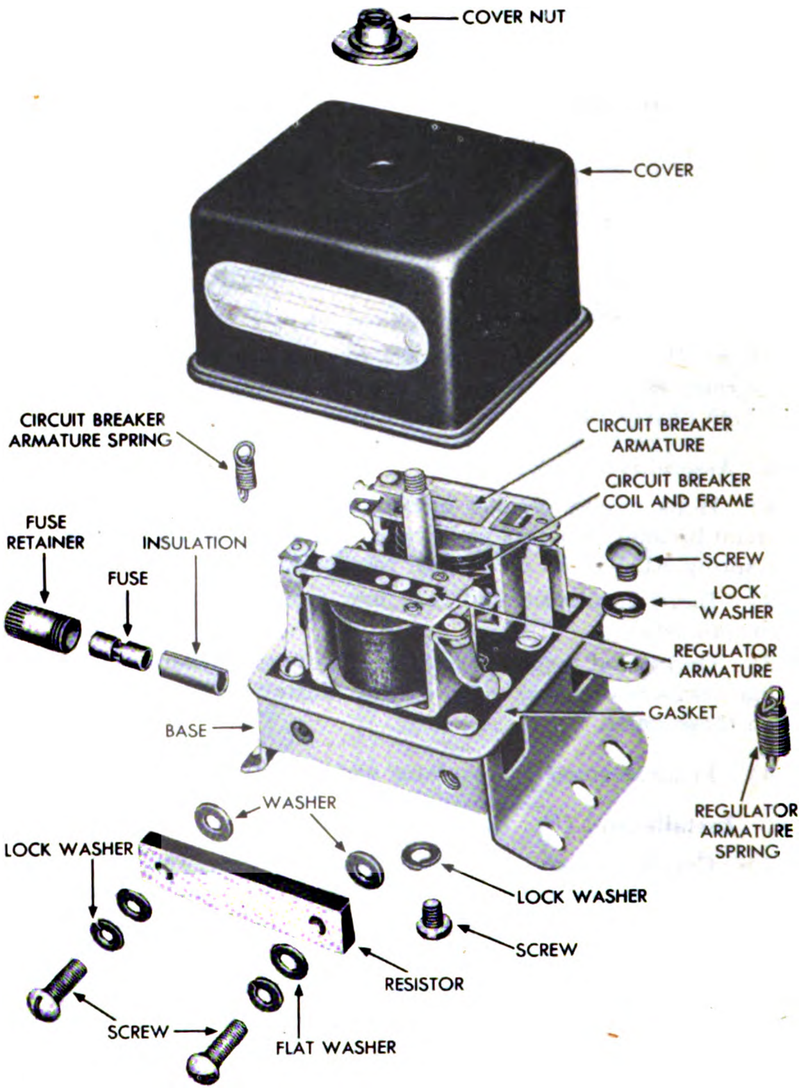


Figure 78—Two-charge Regulator Partially Disassembled

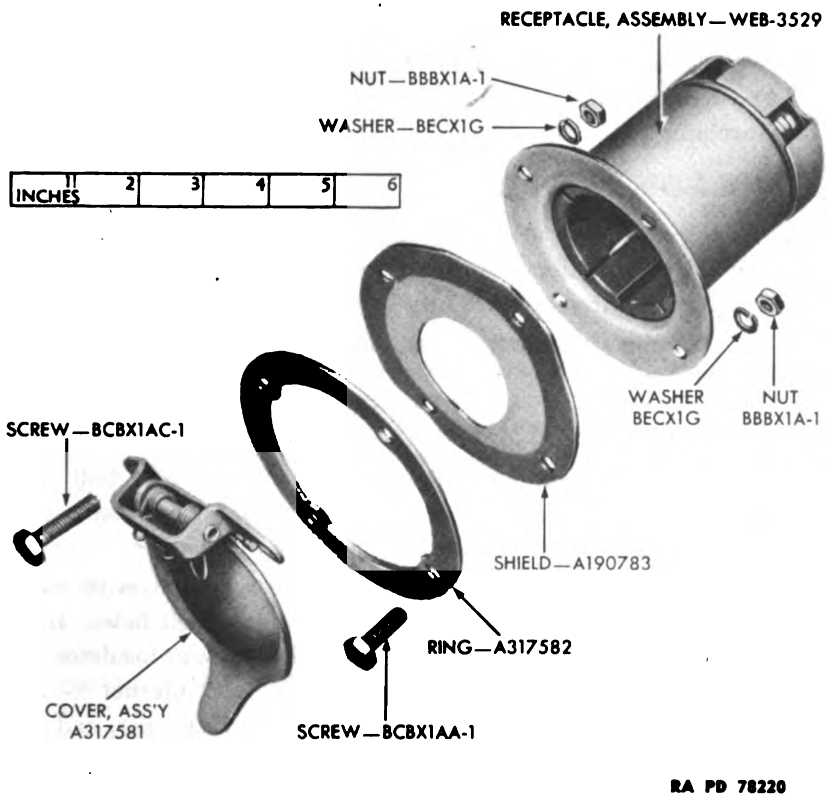


Figure 79—Electric Brake Receptacle Disassembled

Attached to the front side of panel, the cover assembly seals the receptacle when not in use.

b. Removal (fig. 1). Disconnect wire "63" from "TL" terminal on rear of receptacle. Remove the four nuts, lock washers, and screws which attach electric brake receptacle and electric brake cover assembly to panel. Lift cover and ring from front of panel, and socket and shield from rear of panel.

c. Disassembly (fig. 79).

(1) Punch out rivet which holds spring and cover to bracket. Separate the spring and cover from bracket.

(2) Remove nut and lock washer from bolt which attaches cap to rear of case. Lift cap from case.

(3) From each of the four terminal bolts on rear of case, remove two nuts, special washer A190691, plain washer, internal toothed lock

washer, nut, and large plain washers. Pull insert from case and slide terminal bolts and blades from insert.

(4) Remove nut and bolt which attach insulator to rear of case. Lift insulator from case.

d. Inspection and Repair.

(1) Inspect all metal parts to see if they are bent, broken, burred, or worn. Note condition of threads on threaded parts. Remove burs with a mill file. Straighten slightly bent parts if possible.

(2) Examine insulator, insert, and shield to see if they are cracked, broken, or torn.

e. Assembly (fig. 79).

(1) Place insulator in position on back of case with bolt holes alined. Through center hole, insert bolt A325612 from inside case. Install nut on bolt.

(2) Position the four blades in their respective grooves on inside of insert. Slide insert into case and aline terminal bolt holes. Insert the four terminal bolts through blades, insert, case, and insulator. On each terminal bolt, install large plain washer, nut, internal toothed lock washer, plain washer, special washer (dished side in), and two nuts.

(3) Slide cap onto bolt projecting from center of rear of case. Turn cap so large slot is adjacent to terminal bolt marked "TL." Install internal toothed lock washer and nut which attaches cap to case.

(4) Place cover spring in position on cover and place bracket in position on spring and cover. Aline rivet holes of cover, spring, and bracket and slide rivet into position. Crimp over end of rivet.

f. Installation (fig. 1).

(1) Place ring and cover assembly in position on front side of side panel. Insert the two long screws through cover bracket, ring, and panel. Insert the two short screws through ring and panel.

(2) On rear side of panel, slide shield and receptacle into position on the four screws. Install lock washer and nut on each screw.

(3) Connect wire "63" from small terminal block to "TL" terminal bolt on rear of receptacle.

Section VII

ENGINE ELECTRICAL SYSTEM—IGNITION

52. DESCRIPTION.

a. **General** (fig. 80). Components of the ignition system are ignition coil, distributor (with condenser), spark plugs, and necessary wires. Its function is to provide electric sparks across the spark plug electrodes, to cause engine combustion.

b. **Ignition Coil** (fig. 80). This is a self-contained unit. It consists of an iron core around which are wound a relatively few turns of heavy wire connected in the primary circuit, and many turns of fine wire connected in the secondary circuit. Core and coils are enclosed in a sealed case to form the complete coil. Its function is to step up the low-voltage current in the primary circuit to high-voltage current in the secondary circuit. This high voltage is needed to produce a spark across the electrodes of the spark plugs by which the explosive mixture in the cylinders is ignited.

c. **Distributor** (figs. 80 and 81). Principal parts of the distributor are housing (consisting of base and cap), breaker points, shaft and governor, cam, rotor, and condenser. The shaft extends through the length of the body and is geared to the distributor drive gear on the water pump drive shaft. Centrifugal force acts on weights hinged to the shaft. Increased speed throws weights outward and, by means of weight pins through cam, causes the cam to twist slightly. This advances the spark. The shaft also carries the cam and rotor which revolve with it. The cam actuates the breaker points. The function of the breaker points is to open and close the ignition coil primary circuit at the proper times. This causes the field of magnetism in the coil's core to alternately collapse and revive. The collapse, "boosted" by condenser action, causes a surge of high-voltage current in the secondary winding. This high-voltage current travels from the coil to the distributor rotor which discharges it to the proper spark plug. The condenser, located within the distributor, serves to check the flow of current across the distributor points the moment they open. This permits more rapid energization of the secondary windings of the coil, and at the same time prevents burning the distributor breaker points.

d. **Spark Plugs** (fig. 80). Each of the six spark plugs consists of a metal shell encircling an insulator with a central electrode stem. Another electrode is attached to the lower end of the shell. These two electrodes are separated by an 0.025-inch air gap. The top end of the central electrode stem is finished as a terminal to which the wire from the distributor cap attaches. The metal shell is threaded

washer, nut, and large plain washers. Pull insert from case and slide terminal bolts and blades from insert.

(4) Remove nut and bolt which attach insulator to rear of case. Lift insulator from case.

d. **Inspection and Repair.**

(1) Inspect all metal parts to see if they are bent, broken, burred, or worn. Note condition of threads on threaded parts. Remove burs with a mill file. Straighten slightly bent parts if possible.

(2) Examine insulator, insert, and shield to see if they are cracked, broken, or torn.

e. **Assembly** (fig. 79).

(1) Place insulator in position on back of case with bolt holes alined. Through center hole, insert bolt A325612 from inside case. Install nut on bolt.

(2) Position the four blades in their respective grooves on inside of insert. Slide insert into case and aline terminal bolt holes. Insert the four terminal bolts through blades, insert, case, and insulator. On each terminal bolt, install large plain washer, nut, internal toothed lock washer, plain washer, special washer (dished side in), and two nuts.

(3) Slide cap onto bolt projecting from center of rear of case. Turn cap so large slot is adjacent to terminal bolt marked "TL." Install internal toothed lock washer and nut which attaches cap to case.

(4) Place cover spring in position on cover and place bracket in position on spring and cover. Aline rivet holes of cover, spring, and bracket and slide rivet into position. Crimp over end of rivet.

f. **Installation** (fig. 1).

(1) Place ring and cover assembly in position on front side of side panel. Insert the two long screws through cover bracket, ring, and panel. Insert the two short screws through ring and panel.

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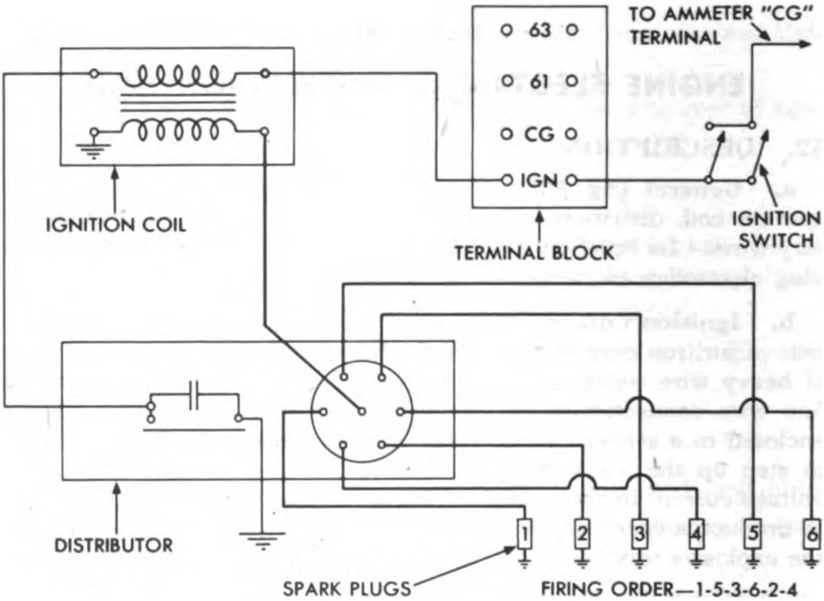
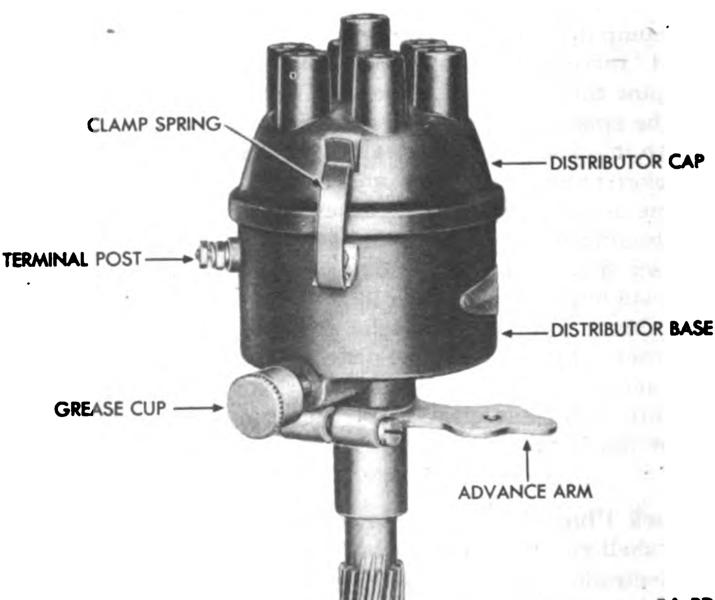


RA PD 78525

Figure 80—Ignition System Diagram



RA PD 78505

Figure 81—Distributor

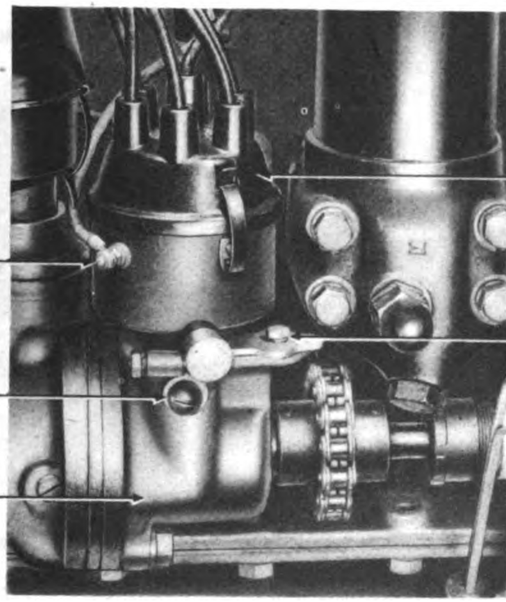


Figure 82—Distributor Installed

to permit screwing into the cylinder head. In operation, the high-voltage current from the distributor arcs across the electrodes to create a spark at the proper instant to ignite the mixture within the cylinder.

53. IGNITION COIL.

a. Test. Remove coil and place in a coil tester. Check spark gap while running free and under load. If spark jumps a ¼-inch gap under load, coil is in satisfactory condition. NOTE: *In absence of coil testing equipment, compare performance with another 12-volt coil known to be good. Replace coil if performance does not equal that of test coil.*

54. DISTRIBUTOR.

a. Removal (fig. 82).

(1) Pull high-tension wires from cap and disconnect primary lead wire from terminal post on side of distributor.

(2) Remove hold-down screw and lock washer. Loosen clamp screw in water pump drive (accessory drive) housing.

(3) Lift distributor from water pump drive housing.

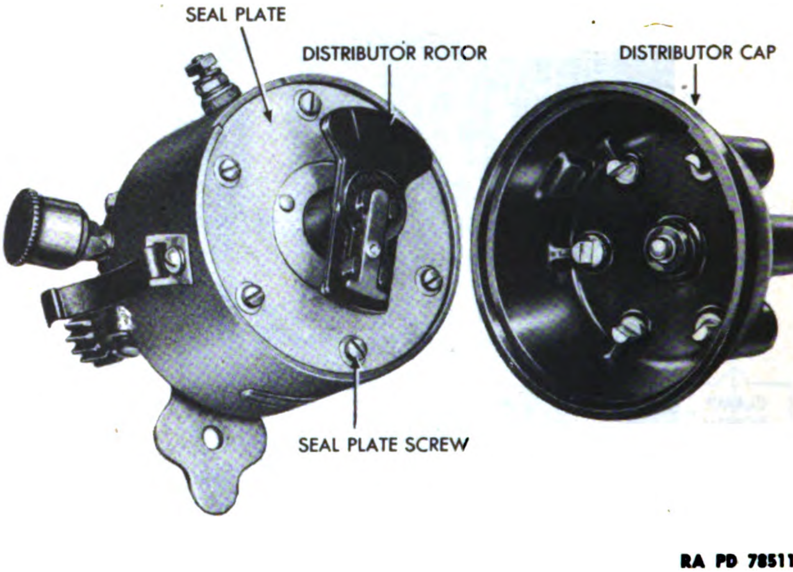


Figure 83—Distributor—Cap Removed

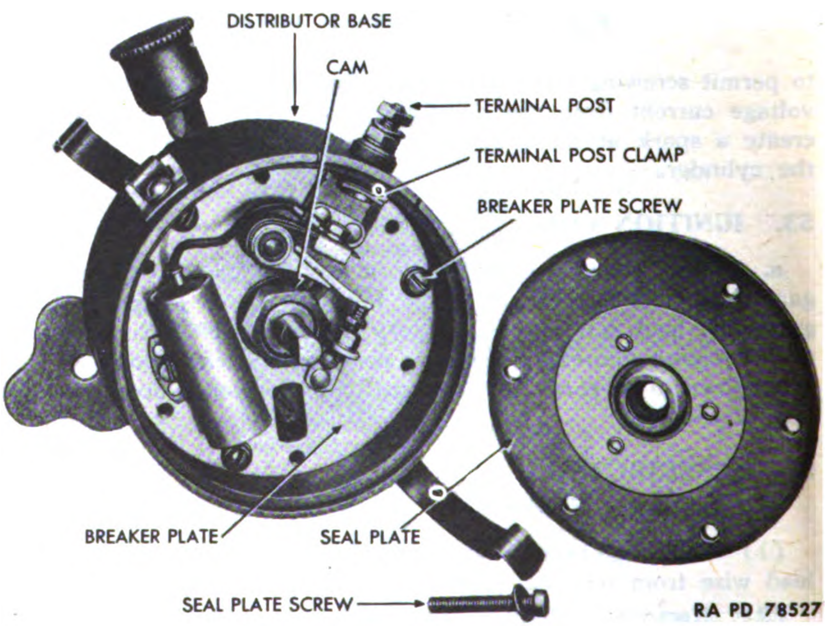


Figure 84—Distributor—Seal Plate Removed

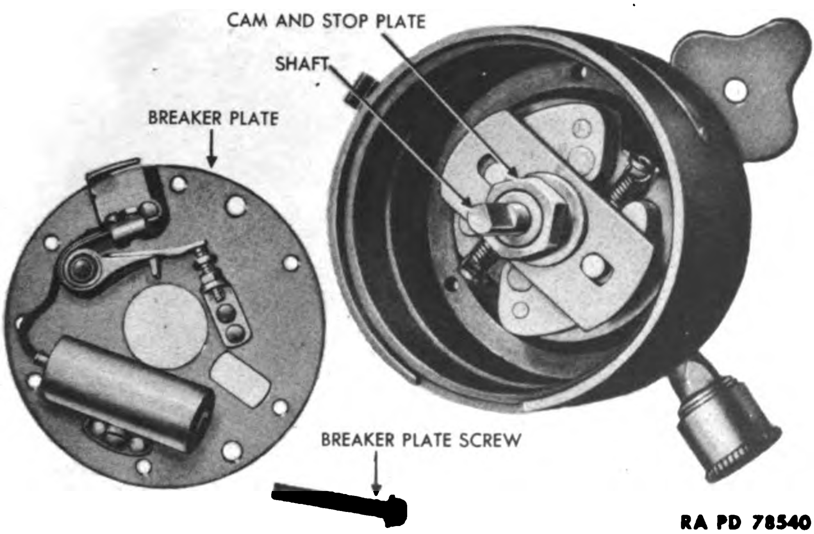


Figure 85—Distributor—Breaker Plate Removed

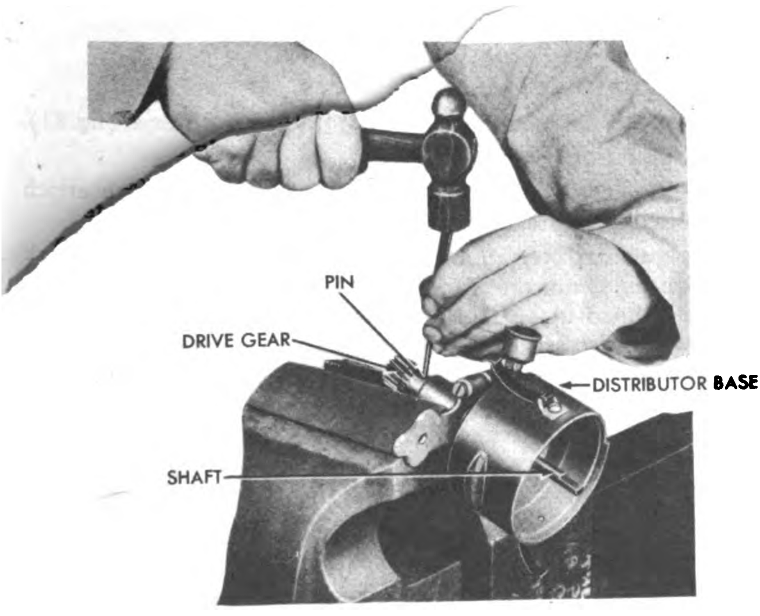


Figure 86—Removing Distributor Gear From Shaft

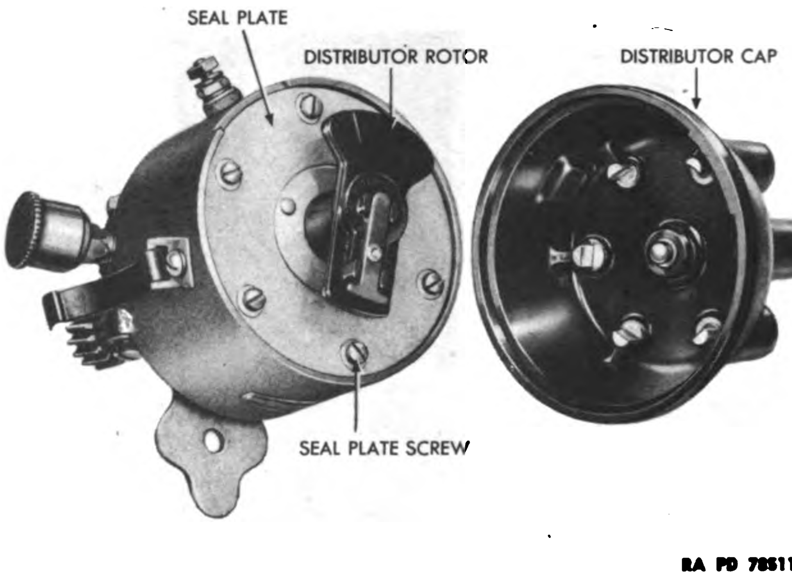


Figure 83—Distributor—Cap Removed

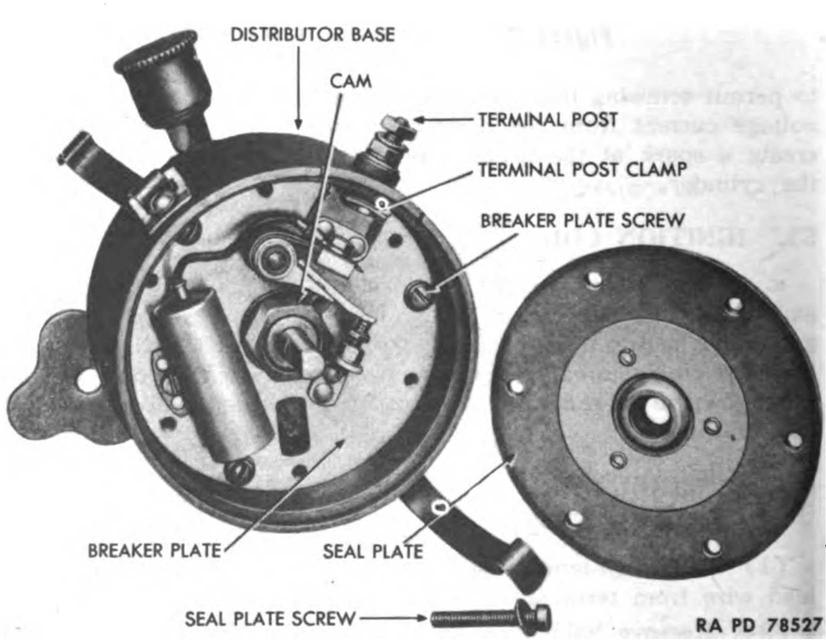


Figure 84—Distributor—Seal Plate Removed

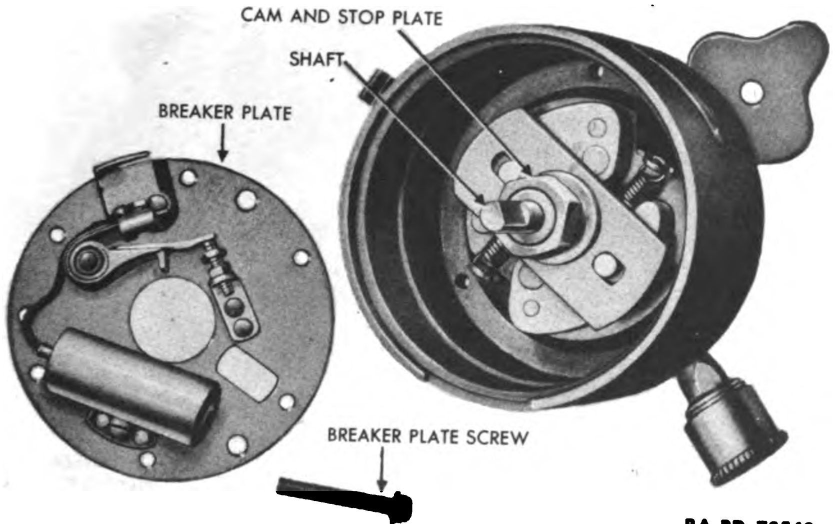


Figure 85—Distributor—Breaker Plate Removed

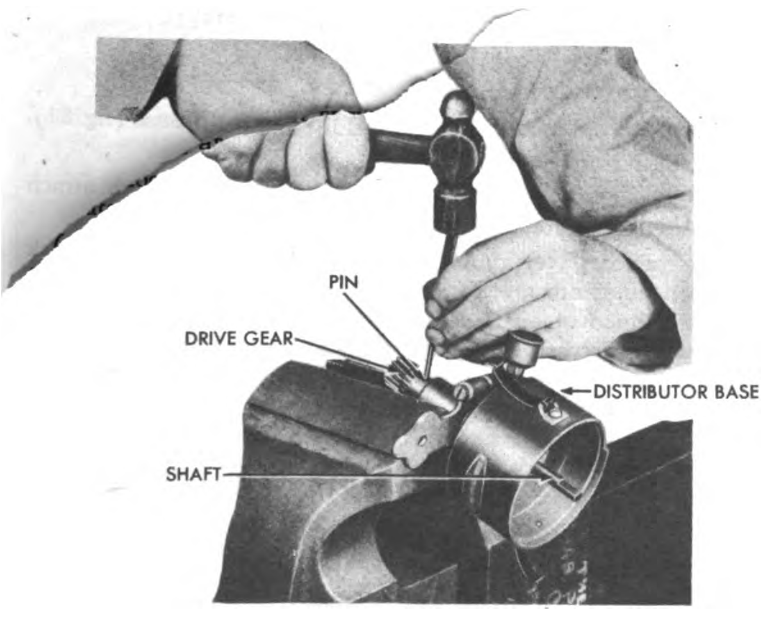


Figure 86—Removing Distributor Gear From Shaft

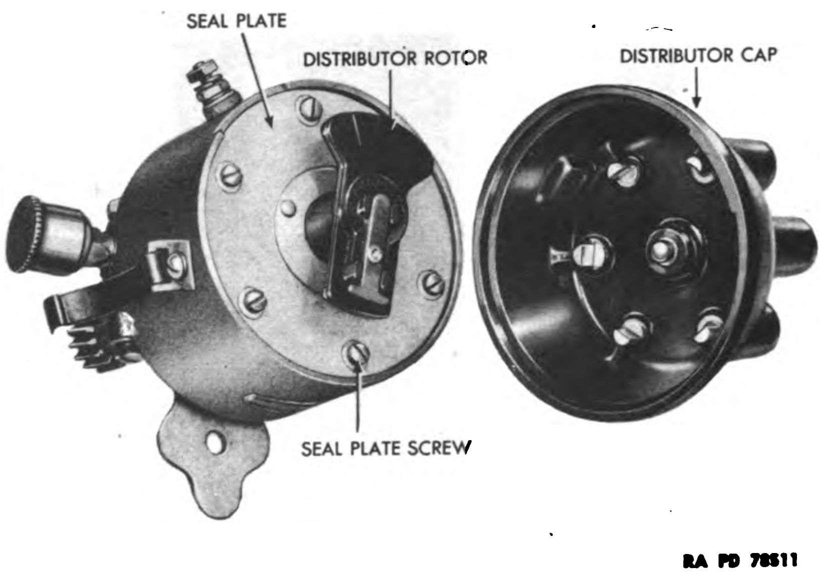


Figure 83—Distributor—Cap Removed

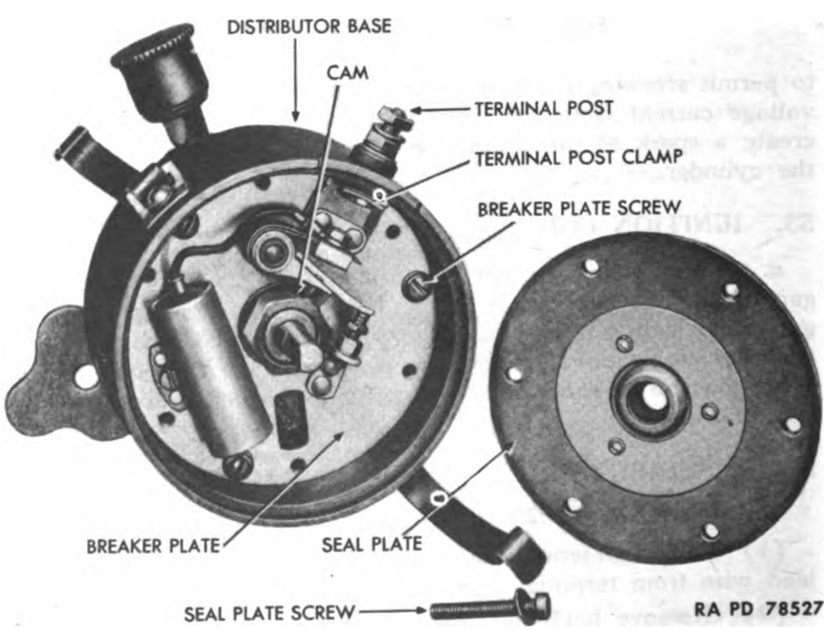


Figure 84—Distributor—Seal Plate Removed

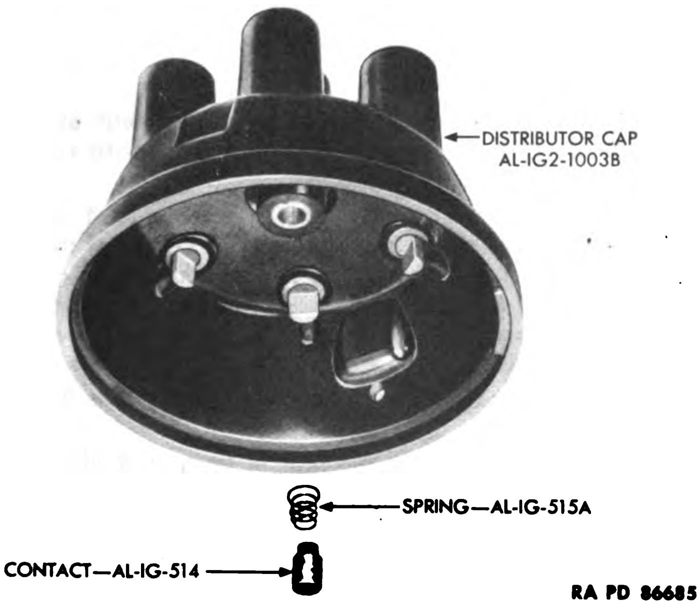


Figure 88—Distributor Cap Disassembled

(2) DISASSEMBLE BREAKER PLATE (fig. 87).

(a) Remove contact spring hexagonal screw and washer and lift breaker spring arm assembly from post on plate.

(b) Loosen lock nut and screw breaker screw contact from angle on plate.

(c) Remove condenser mounting screw and lock washer and lift condenser from breaker plate.

(3) DISASSEMBLE BASE (fig. 81).

(a) Remove screw and lock washer which attaches each spring clamp to base. Lift clamps from base.

(b) Screw grease cup from base.

(c) Press the two absorbent bronze bearings from base if replacement of bearings is found necessary (subpar. c (8), below).

(d) Remove nut, washer, and bolt from advance arm. Slide advance arm and washer from underside of base.

(4) DISASSEMBLE SHAFT AND GOVERNOR.

(a) Pull weight springs from pins on weights and weight plate.

(b) Lift weights from pivots.

(5) DISASSEMBLE CAM AND STOP PLATE. Pull anti-rattle spring from stop plate.

c. **Inspection and Repair.**

(1) Clean all metal parts in dry-cleaning solvent, and dry with compressed air. Clean distributor cap and rotor with carbon tetrachloride and dry with a clean cloth.

(2) Inspect cap for cracks, carbon streaks and corroded or burned inserts. Note condition of plunger at center of inside of cap to see if it is broken or badly burned. Depress plunger contact with the finger to see if it binds or if spring fails to return it to normal position. Replace cap if it is cracked, if the carbon is streaked, or if inserts are corroded. Replace cap and rotor if inserts are burned.

(3) Inspect rotor for cracks or burned tip. Replace if either condition is present.

(4) Inspect seal plate to see if it is bent or if fiber or rubber seals are worn, torn, or deteriorated.

(5) Check condenser on an M1 Circuit Tester. Connect bare clip of low-tension lead to a ground on an engine. Connect red clip to battery or starting switch terminal. Insert condenser in clip on tester, and attach short test lead to condenser pig tail. Place coil test switch at "test coil." Turn on rotor switch, and adjust variable spark gap to highest setting obtainable without missing. Move condenser test switch to "vehicle cord," and observe effect on high-tension output and on arcing at tester breaker contacts. Repeat test several times, changing position of condenser pig tail lead. If switching to "vehicle cord" does not result in arcing and spark does not miss, and if changing position of condenser pig tail does not effect action, condenser is in satisfactory condition. Replace condenser if it fails on any one or more of the above tests.

(6) INSPECT BREAKER CONTACTS. If they are grayish color and not more than slightly pitted, they can be used again. Test fit of breaker arm on pivot to see if it binds or has excessive side play. Clean up slightly pitted contacts with a stone. Do not file. Replace discolored, badly pitted, or worn contacts. Replace breaker arm if it binds or fits loosely on pivot.

(7) Inspect governor weights, plate, and shaft for wear or scoring. Inspect springs for distortion. Pack pockets in laminated weights with seasonal grade, general purpose grease (No. 0). Reassemble governor, making sure weight springs have small loops on weight pins.

(8) Inspect base to see if it is broken. Inspect bearings to see if they are scored. Test fit of bearings on shaft.

(9) Inspect cam, breaker plate, gear, pin, clamp springs, antirattle spring, grease cup, advance arm, screws, nuts, and washers to see

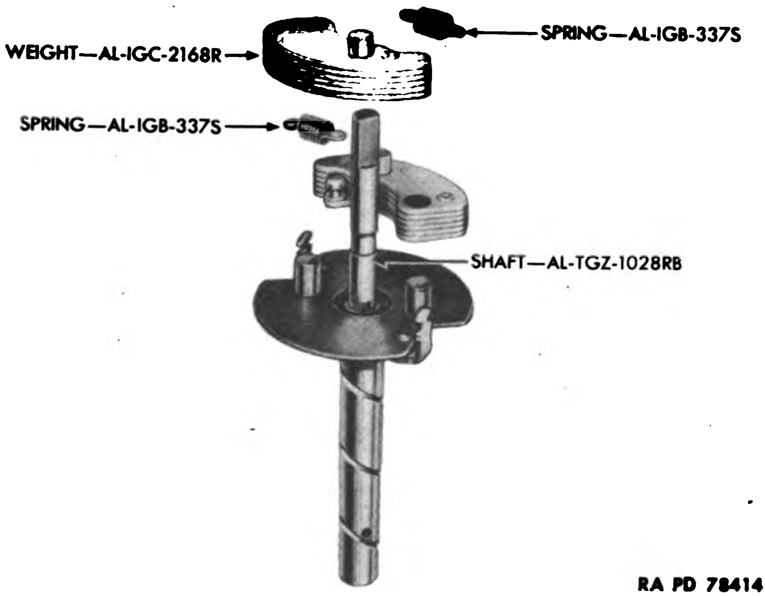


Figure 89—Distributor Shaft Disassembled

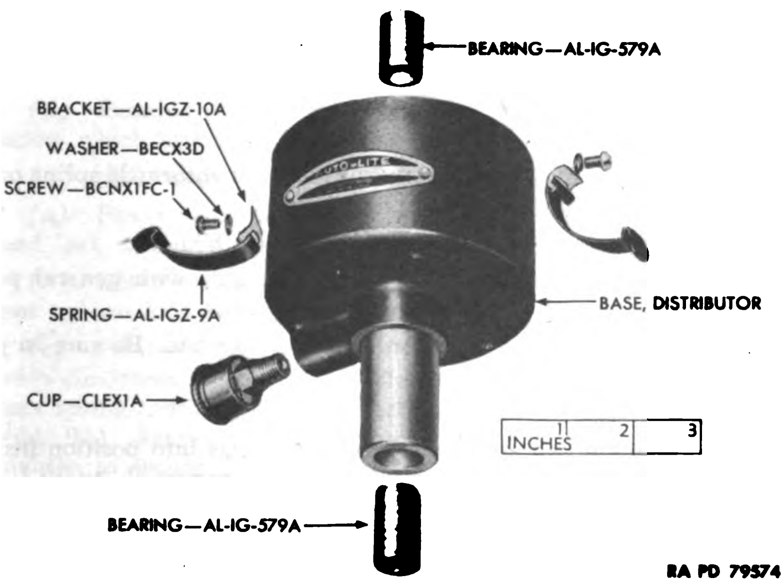


Figure 98—Distributor Base Disassembled

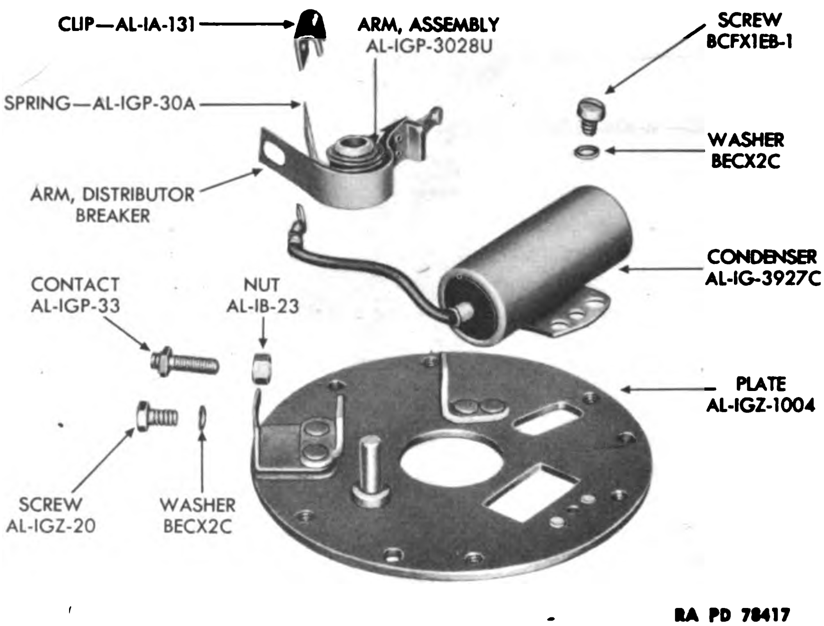


Figure 91—Distributor Breaker Plate Disassembled

if any are bent, broken, scored, worn, or burred. Note condition of threads on threaded parts. Remove burs with a file. Replace distributor assembly, if unrepairable.

d. Assembly.

(1) ASSEMBLE CAM AND STOP PLATE. Push anti-rattle spring onto shaft and insert bent end into spring hole.

(2) ASSEMBLE SHAFT AND GOVERNOR (fig. 89).

(a) Fill grease pockets in laminated weights with general purpose grease (No. 0). Position weights on pivots.

(b) Install springs on pins, on weights and plate. Be sure to put small spring loops on the weight pins.

(3) ASSEMBLE BASE (fig. 90).

(a) Press the two absorbent bronze bearings into position inside base. Make lower bearing flush with base. Countersink upper bearing. Spread a film of general purpose grease on bearings as prescribed in TM 9-617.

(b) Position advance arm on base with screw hole centered under manufacturer's name plate on base. Install the bolt, washer, and nut which clamp advance arm to base.

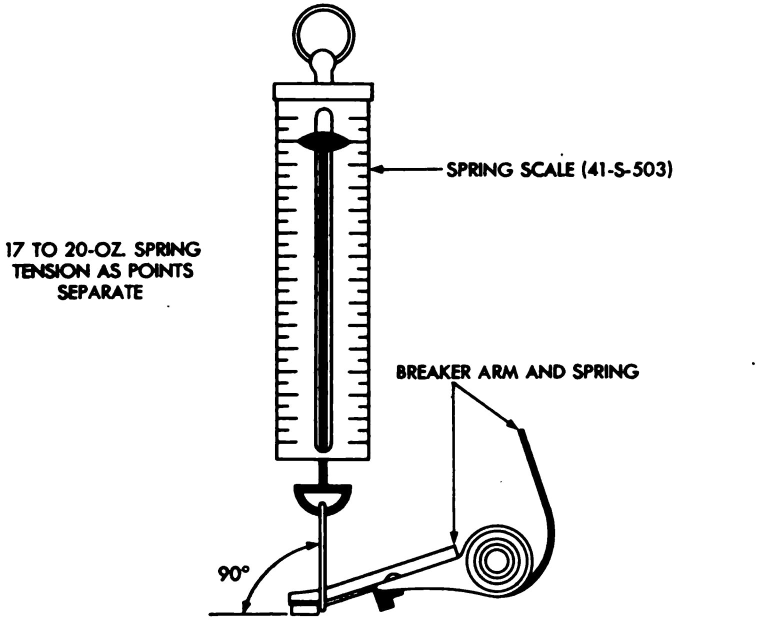


Figure 92—Measuring Breaker Point Spring Tension

(c) Fill grease cup with seasonal grade, general purpose grease and screw into place in base.

(d) Position clamp springs on base and install lock washer and screw which attach each clamp.

(4) ASSEMBLE BREAKER PLATE (fig. 91).

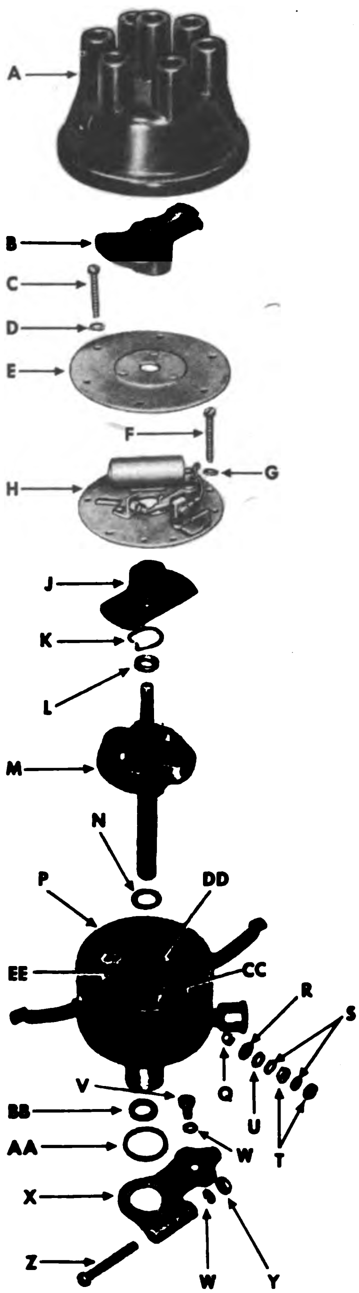
(a) Position condenser on base. Install condenser mounting screw and lock washer.

(b) Screw breaker screw contact into approximate position but do not tighten lock nut.

(c) Position breaker spring arm on pivot. Place spring in position with condenser pig tail lug over screw hole. Install washer and contact spring hexagonal screw. Test spring tension with a spring scale (fig. 92). Loosen contact spring hexagonal screw and loosen or tighten to secure 17 to 20 ounces tension.

(5) ASSEMBLE SUBASSEMBLIES (fig. 93).

(a) Slide washer onto lower end of shaft and position governor and shaft within base. Slide washer onto protruding shaft. Aline pinholes in gear and shaft and press gear onto shaft. Drive pin through gear and shaft. Peen pin.



A—CAP, ASSEMBLY—AL-IGZ-1003B
B—ROTOR—AL-IGZ-1016
C—SCREW—BCFX2AM-1
D—WASHER—AL-8X-350
E—PLATE—AL-IGZ-1005
F—SCREW—BCFX2AN-1
G—WASHER—BECX3D
H—PLATE, ASSEMBLY—AL-IGZ-2004A
J—CAM—AL-IGZ-1021RH
K—SPRING—AL-IGE-35
L—SPACER—AL-IGS-99
M—SHAFT, ASSEMBLY—AL-IGZ-2028R
N—WASHER—AL-IGS-104
P—BASE, ASSEMBLY—AL-IGZ-2011A
Q—BUSHING—AL-IGL-10
R—WASHER—AL-IGL-9
S—WASHER—BECX1E
T—NUT—BBKX2CA-1
U—WASHER—AL-8X-183B
V—SCREW—BCAX3K-1
W—WASHER—BECX3G
X—ARM—AL-IGC-2024AQ
Y—NUT—BBJX1A-1
Z—SCREW—BCFX2DR-1
AA—WASHER—AL-IG-816E
BB—WASHER—AL-IG-90
CC—INSULATION—AL-IGZ-15
DD—CLAMP—AL-IGZ-18
EE—POST—AL-IGL-8A

RA PD 78416

Figure 93—Distributor Disassembled

RA PD 79564

Figure 94—Distributor in Test Fixture

(b) Slide cam and stop plate onto top end of shaft, guiding weight pins into openings in stop plate.

(c) Insert breaker plate into top of base. Slide inside insulation onto primary terminal post and insert post through post hole from inside base. Slide insulating bushing around post into countersunk hole in body. Twist breaker plate clockwise to engage terminal post, guiding inside insulation between contact on plate and base. Place U-shaped post clamp over head of terminal post inside base. Install insulating washer, flat washer, lock washer, and nut on post, tightening securely. Install outside lock washer and nut on post fingertight. Install the three screws and lock washers which secure breaker plate to base.

(d) Adjust breaker point gap to 0.020 $\pm$ 0.002 inch and tighten lock nut on breaker screw contact.

(e) Position seal plate over top of base. Install the six washers and screws which attach seal plate to breaker plate.

(f) Push rotor in position on top of shaft.

(g) Position cap on base and hook the two clamp springs.

e. **Tests and Adjustments.**

(1) Place distributor, with cap, rotor, and seal plate removed, on a test fixture and set controls to measure cam angle or dwell (fig. 94). Operate distributor up and down speed range and note fluctuations in meter. Excessive fluctuation is caused by worn cam or a sticking contact arm on its pivot. Adjust reading to 41 degrees by changing contact point gap. Tighten lock nut after each adjustment. This operation can be done with distributor mounted on engine if only M1 Ignition Circuit Tester is available.

(2) Adjust centrifugal advance as given below. This operation can be done only in a fixture that will show firing point in degrees and distributor speed in revolutions per minute.

(a) Run distributor at 250 revolutions per minute and set dial at zero degree.

(b) Increase speed to 1,150 revolutions per minute and note advance. Specifications are 6 distributor degrees. If maximum advance is not within specifications, reduce speed below 300 revolutions per minute and note whether or not indicator drops below zero. If an indication below zero is shown, stop distributor. Bend lugs on outer spring bracket slightly toward center (fig. 95) and again check at 1,150 revolutions per minute. If advance is still not 6 degrees, stop distributor and relieve spring tension slightly by bending outer spring brackets (fig. 95). Advance specifications for distributor at various speeds are as follows:

RA PD 78524

Figure 95—Distributor Centrifugal Advance Adjustment

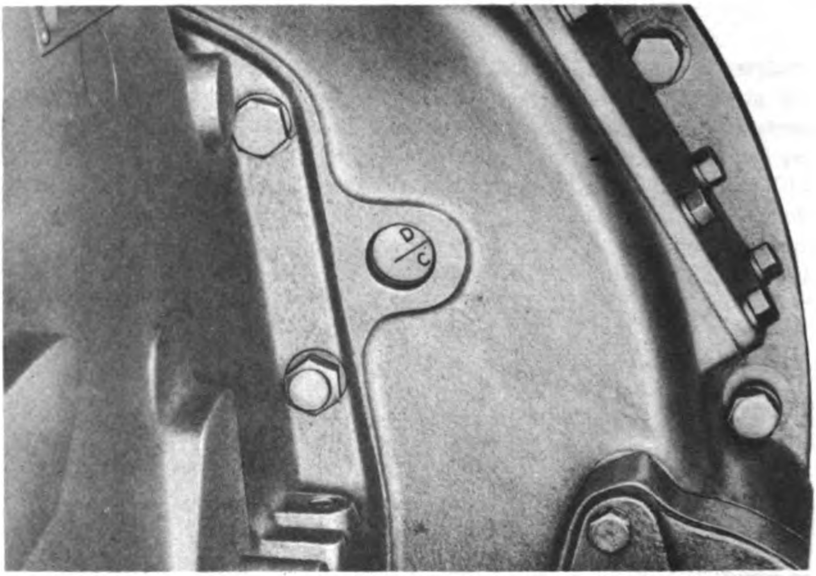
300 rpm	0 deg
450 rpm	1 deg
725 rpm	3 deg
1000 rpm	5 deg
1150 rpm	6 deg

f. **Installation** (fig. 82).

(1) Remove No. 1 (front) spark plug. Close plug hole with thumb and slowly hand-crank engine. Pressure on thumb indicates compression stroke. Continue cranking slowly until "DC" mark on flywheel is centered in peephole on front left side of flywheel bell housing. "DC" mark is accentuated by white paint.

(2) Remove cap from distributor. Turn rotor so it points to position of one of the inserts in cap. Distributor is then in No. 1 firing position.

(3) Place distributor down into position in water pump drive housing. Watch rotor as distributor gear engages gear on water pump drive. If rotor turns, withdraw distributor and reset rotor in No. 1 firing position, allowing for turn when gears mesh. Again position distributor in water pump drive housing.



RA PD 78575

Figure 96—Flywheel Timing Marks

(4) Install hold-down screw and lock washer. Tighten clamp screw on water pump drive.

(5) Connect primary lead wire to terminal post on side of distributor base.

(6) Install cap on base and insert high-tension secondary lead wire from coil into center tower of cap.

(7) Push wire from No. 1 spark plug into tower on cap to which rotor was pointed in step (2), above. Continue around cap, clockwise, installing wires from cylinders 5, 3, 6, 2, and 4, respectively.

(8) Time distributor (subpar. g, below).

g. Time Distributor.

(1) Attach one wire of a neon timing light to top terminal of No. 1 spark plug, and connect the other wire to ground. Start engine and run at idling speed.

(2) Point timing light through peephole in front left side of bell housing at timing marks on flywheel (fig. 96).

(3) If "DC" mark appears to be centered in peephole, timing is correct (fig. 96). Otherwise, loosen distributor clamp screw and advance arm clamp screw. Slowly rotate distributor to right or left until "DC" mark is centered. Tighten screws.

55. SPARK PLUGS.

a. 100-hour Inspection and Repair.

(1) Examine manufacturer's symbol on porcelain. It should be Champion No. 1 "COMM," or equivalent. This is a cold plug. Under no circumstances should a hot type be used. Replace plugs if of wrong type.

(2) Inspect electrodes and replace plugs if electrodes are burned.

(3) Examine porcelains. Replace plugs having cracked or broken porcelains. Note color of porcelains and interpret as follows:

Color	Cause	Correction
Dead white	Running hot	Use colder type plug such as Champion No. 1 COMM, or equivalent.
Light brown	Normal	None
Glossy black	Oil in cylinder	Check rings and pistons. Replace worn and broken parts.
Dull black	Rich fuel mixture weak ignition, improper spark plug gap, or weak compression.	Check for presence of each suggested cause and make necessary repairs.

(4) Clean each spark plug on sand blast spark plug cleaner. Clean all sand from spark plug with compressed air.

(5) Adjust gap to 0.025 inch (wire-type feeler gage) by bending outer electrode.

(6) Test spark plugs under 110 pounds air pressure in a spark plug testing fixture. Replace plugs if spark appears weak, and coil and condenser test satisfactorily.

Section VIII

ENGINE ELECTRICAL SYSTEM—STARTING MOTORS

56. BENDIX DRIVE ASSEMBLY.

a. Description (fig. 104). The Bendix drive consists of a threaded sleeve fastened to the starting motor armature shaft through a drive spring and a pinion mounted on the threads of the sleeve.

b. Operation. When the starting motor circuit is closed, the armature revolves, turning the sleeve within the pinion. The threads on the sleeve force the pinion to travel on the sleeve and, as it reaches the outer end of the sleeve, the external teeth of the sleeve mesh with the external teeth of the flywheel. The pinion turns the flywheel,

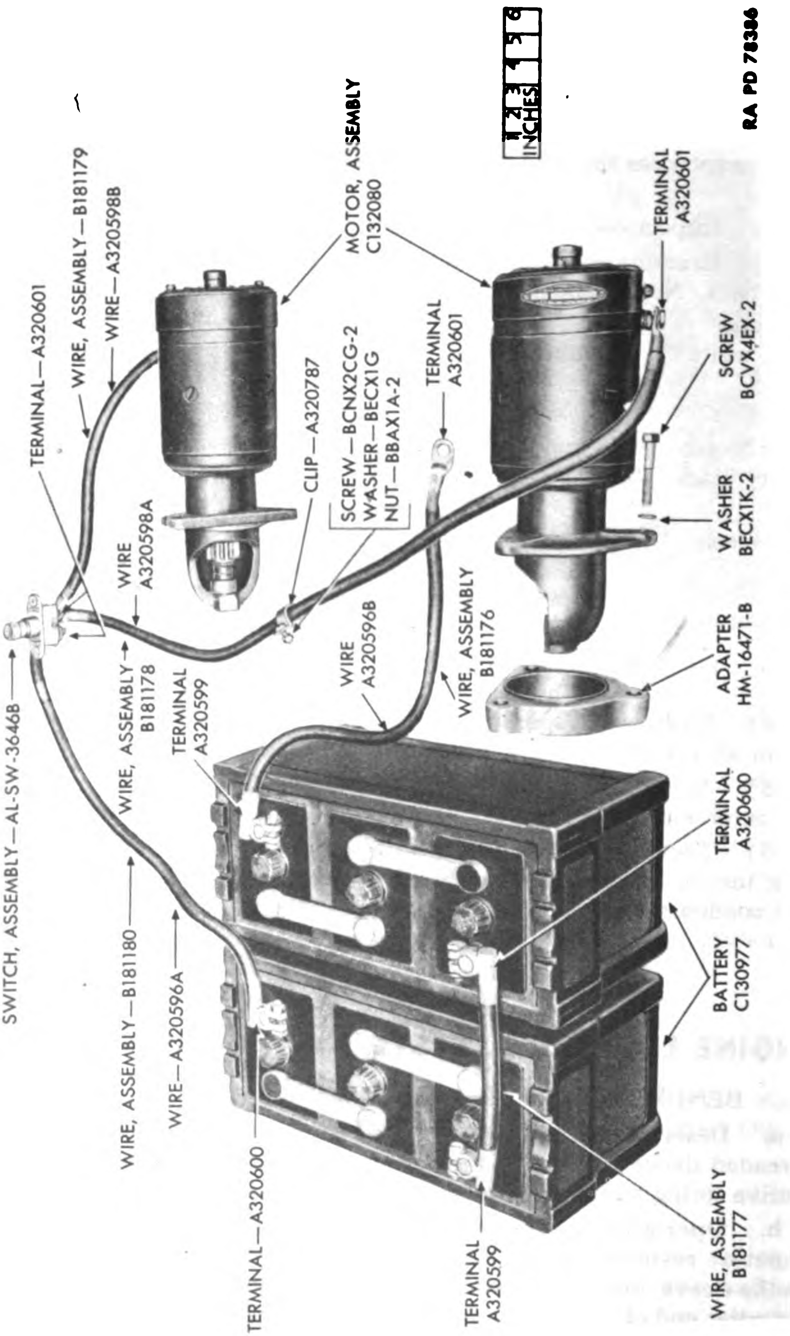


Figure 97—Starting System Components

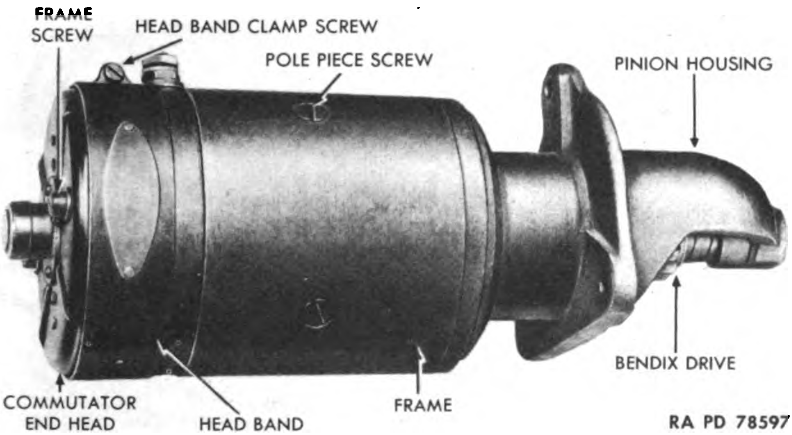


Figure 98—Starting Motor Removed

cranking the engine. When the engine fires and the rotating speed of the flywheel exceeds the speed of the pinion, the pinion is forced back on the threads of the sleeve, and is disengaged from the flywheel teeth.

57. STARTING MOTORS.

a. **Disassembly** (figs. 97 and 98).

(1) Loosen head band clamp screw and slide band from head.

(2) Disconnect the two field coil lead wires from insulated brushes.

(3) Remove the two frame screws and lock washers. Hold up brushes and pull commutator end head from frame. Slide thrust washer from armature shaft. Lift pinion housing from other end of frame. Slide armature from frame and field.

(4) Remove spring shaft screw and spring head screw (each with a special lock washer) from Bendix drive. Pull pinion assembly and spring from armature shaft. Press driving head from shaft. Tap key from armature shaft. Slide intermediate bearing and washer from armature shaft.

(5) Remove brush screws and brush lead wire ground screws. Lift brushes and brush ground connectors from commutator end head. Pull brush post clips from posts. Remove insulating washers, bushings, brush spring, brush holders, spring insulators, and brush holder spacing insulators from posts.

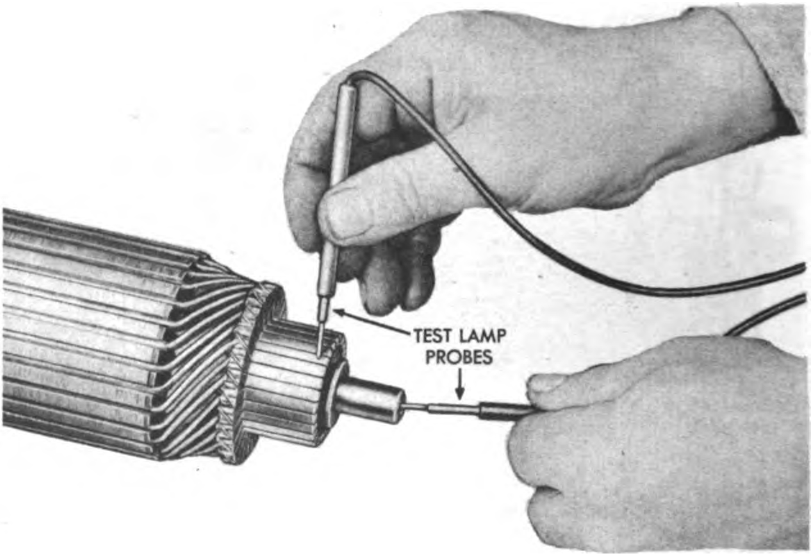


Figure 99—Testing Starting Motor Armature for Grounded Circuit

b. Inspection and Repair.

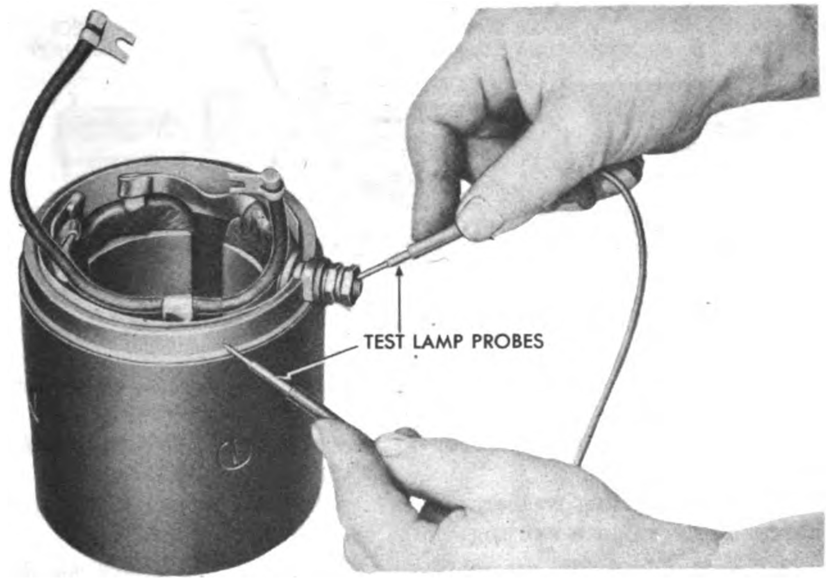
(1) ARMATURE.

(a) *Clean Commutator.* If commutator is dirty or discolored, hold a piece of flint paper (No. 2/0) against the commutator while turning armature slowly. Blow sand off commutator after dressing.

(b) *Repair of Rough or Worn Commutator.* If commutator is rough or worn, place armature in a lathe. Take as light a cut as possible from commutator to remove roughness. Do not undercut mica between commutator bars. NOTE: *Lathe cutting tool must be sharp to avoid burring commutator. If burs are present after taking the cut, replace armature.*

(c) *Test Armature for Grounds* (fig. 99). Hold one probe of test lamp to the core or shaft (not on bearing surfaces). Touch each commutator segment with other probe of test lamp. If lamp lights at any time, the winding is grounded. Replace armature if grounded.

(d) *Test Armature for Shorts.* Place armature on a growler and turn on growler. Hold a thin strip of steel on the core. Rotate armature slowly by hand. If steel strip vibrates, armature is shorted. Replace armature if shorted.



RA PD 78583

Figure 100—Testing Starting Motor Field for Grounded Circuit

(e) Test Armature for Open Circuit. Touch probe of test lamp to each pair of adjacent commutator bars in turn. If lamp fails to light on any test, an open circuit is indicated. Replace armature if open.

(2) FRAME AND FIELD.

(a) Test Field Coils for Grounds (fig. 100). Bend the two loose leads so that neither touches frame or field. Hold one probe of test lamp on frame. Touch terminal post with other test lamp probe. If test lamp lights, a grounded circuit is indicated. To locate the grounded circuit, disassemble terminal post and repeat test. If test lamp still lights, ground is in field coil. If it no longer lights, the ground is in terminal post.

(b) Test Field Coil and Leads for Open Circuit. Hold one point of test lamp on terminal post. Touch each lead, in turn, with the other point of test lamp. If test lamp fails to light in either instance, a field coil or lead is open.

(c) Repairing a Ground or Open Circuit in Frame Assembly.

1. Disassembly frame assembly (figs. 101 and 102). Remove two nuts, insulating washer, and terminal post cover insulation from terminal post, and remove the four pole piece screws (figs. 101 and 102). Lift pole pieces and coils from frame. Lift terminal post frame

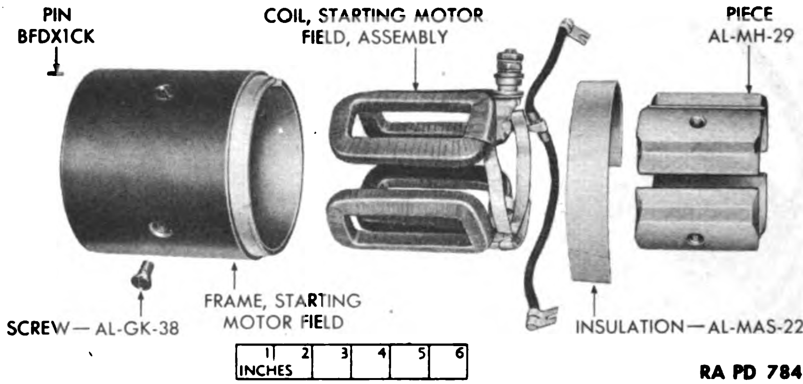


Figure 101—Starting Motor Frame and Field Disassembled

insulation, insulating washer, and flat washer from terminal post. If unrepairable, replace starting motor assembly.

2. *Assembly frame assembly* (figs. 101 and 102). Place the flat washer, insulating washer, and terminal post frame insulating bushing on the terminal post. Place the field coils, insulation, and pole pieces in position in frame. Dip pole piece screw in shellac. Install the pole piece screws. Strike the frame a few sharp blows with a rawhide mallet as the screws are being tightened to aline pole pieces. Install terminal post cover insulator, insulating washer, lock washer, nut, second lock washer, and second nut on the terminal post.

(3) PINION HOUSING.

(a) Clean pinion housing in dry-cleaning solvent, and dry with compressed air.

(b) Examine pinion housing for fractures.

(c) Fit armature shaft into the end bearing and check side play.

(4) BENDIX DRIVE AND INTERMEDIATE BEARING PLATE.

(a) Clean all parts in dry-cleaning solvent, and dry with compressed air. Examine all parts to see if they are broken, bent, chipped, or worn.

(b) Inspect the intermediate bearing plate for wear or distortion. Fit intermediate bearing on armature shaft and check for side play. Spin plate on shaft, and note if it is warped.

(5) COMMUTATOR END HEAD.

(a) Clean commutator end head and all parts except brushes and fiber insulators in dry-cleaning solvent. Blow dry with compressed air.

(b) Inspect all parts for scoring, distortion, and breakage.

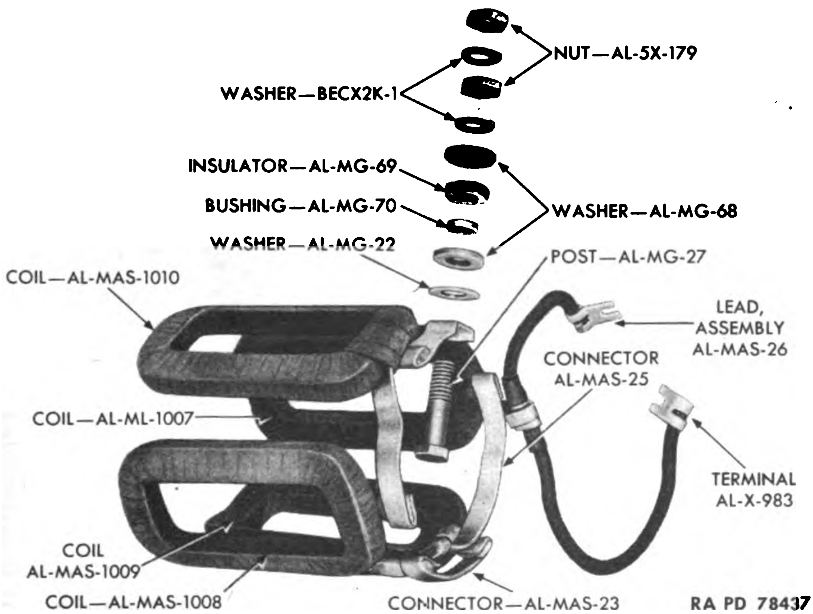


Figure 102—Starting Motor Field Disassembled

(c) If brushes are worn to less than half their original length, replace with new ones. Compare the old brush with a new one to determine the amount of wear.

c. **Assembly** (fig. 103).

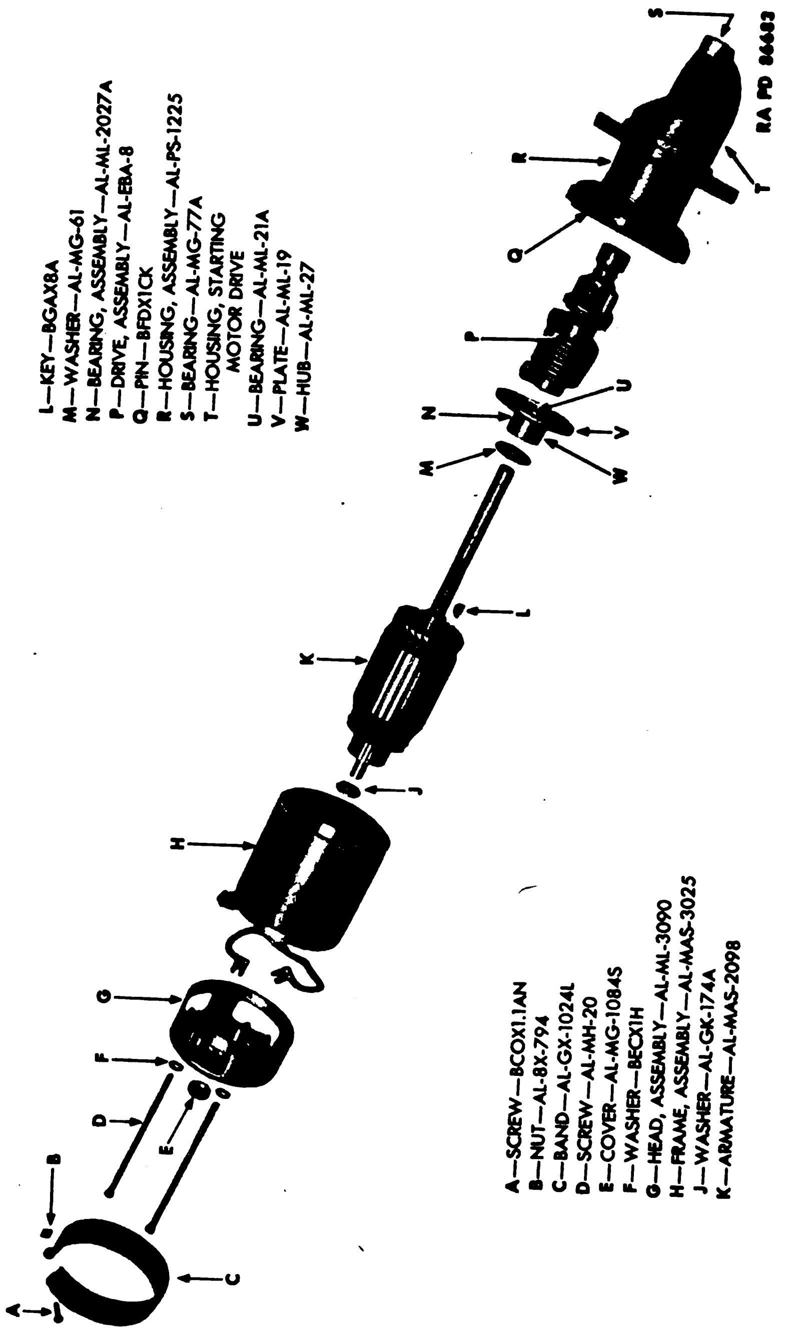
(1) On brush holder posts on inside of commutator end head, install brush holder spacing insulators, spring insulators, brush holders, brush springs, insulating bushings, and washers. Install brush post clips on posts (fig. 105).

(2) Place brushes and ground connectors in position within commutator end head. Install brush lead ground screws. Install brush screws (fig. 105).

(3) Coat bearing and bearing surface on armature shaft with engine oil (SAE 10), and slide washer and intermediate bearing plate into position on armature shaft.

(4) Tap key to seat in keyway on armature shaft. Slide Bendix drive head over key and shaft and press onto shaft until screw hole in head and shaft are alined.

(5) Slip spring and pinion assembly into position on armature shaft. Aline screw holes in spring and heads, and install special washer



A—SCREW—BCOX1.1AN
B—NUT—AL-8X-794
C—BAND—AL-GX-1024L
D—SCREW—AL-MH-20
E—COVER—AL-MG-1084S
F—WASHER—BECX1H
G—HEAD, ASSEMBLY—AL-ML-3090
H—FRAME, ASSEMBLY—AL-MAS-3025
J—WASHER—AL-GK-174A
K—ARMATURE—AL-MAS-2098

L—KEY—BGAX8A
M—WASHER—AL-MG-61
N—BEARING, ASSEMBLY—AL-ML-2027A
P—DRIVE, ASSEMBLY—AL-EBA-8
Q—PIN—BFDX1CK
R—HOUSING, ASSEMBLY—AL-PS-1225
S—BEARING—AL-MG-77A
T—HOUSING, STARTING MOTOR DRIVE
U—BEARING—AL-ML-21A
V—PLATE—AL-ML-19
W—HUB—AL-ML-27

Figure 103—Starting Motor Disassembled

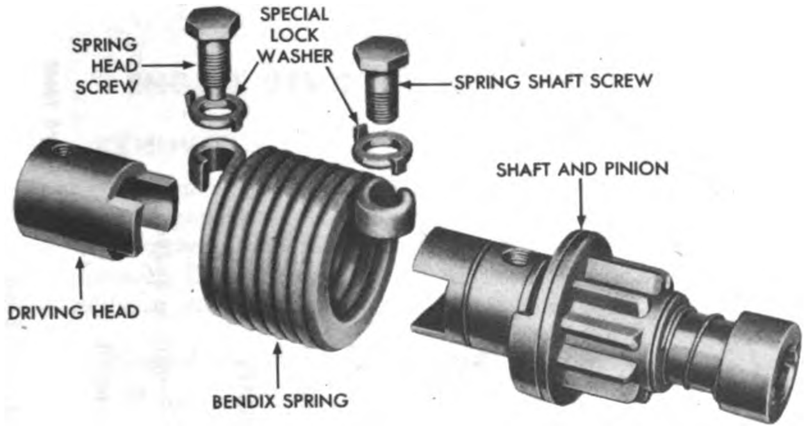


Figure 104—Bendix Drive Disassembled

and spring shaft screw. Also install special washer and spring head screw (doweled). Tighten both screws securely and bend ears on special washers to lock screws (fig. 104).

(6) Coat bearings in pinion housing and commutator end head, as well as bearing surfaces on armature with engine oil (SAE 10).

(7) Slide pinion housing over Bendix drive. Make certain intermediate bearing plate is tight against its seat in housing, with dowel in housing through slot in plate.

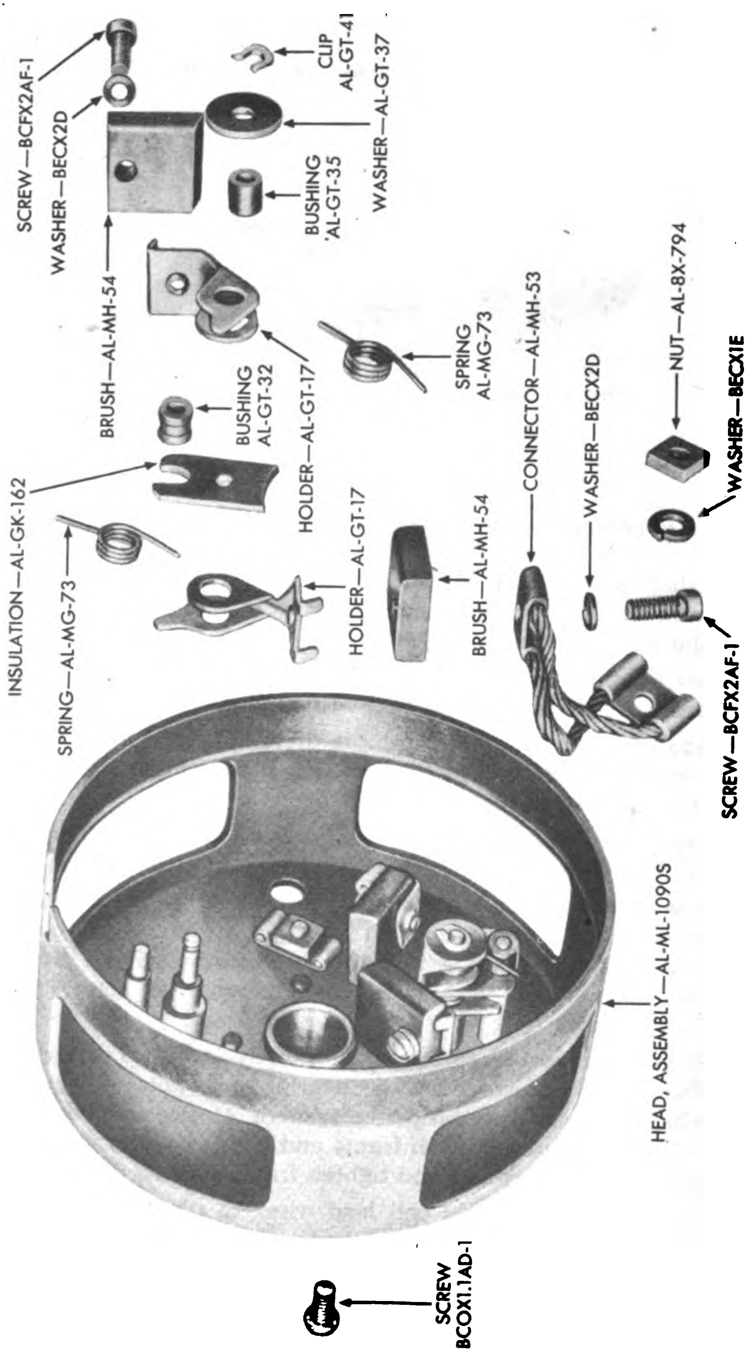
(8) Position armature and pinion housing in frame and field assembly, and aline pinion housing on dowel projecting from frame.

(9) Slide thrust washer onto front end of armature shaft. Raise brushes and position commutator end head on armature shaft and against frame. Install the two lock washers and frame screws. Strike frame a few sharp blows with a rawhide hammer as screws are tightened.

(10) Revolve armature to assure proper assembly of the components. Should bind exist, the three bearings are not in line, the cause of which is usually improper alinement of the intermediate bearing. Slide pinion housing from frame and check position of intermediate bearing plate. Replace and tighten frame screws.

(11) Connect the two field coil lead wires to the two insulated brushes.

(12) Position head band over openings in commutator end head and tighten clamp screw. If bearing cover was removed, tap it to seat over shaft boss on outside of commutator end head.



RA PD 78405

Figure 105—Starting Motor Commutator End Head Disassembled

Section IX

ENGINE REMOVAL AND DISASSEMBLY

58. REMOVAL.

a. General. There are two alternatives for engine removal. Engine and generator assembly can be removed as a unit, or engine can be removed alone. Choose the method which fits the purpose of the removal. Both alternatives are given below, engine and generator assembly in subparagraph **b**, engine alone in subparagraph **c**.

b. Engine and Generator Assembly Removal.

(1) Remove all four doors, all four side panels, hood, instrument panel (par. 92), battery and tool box shelf, rear upright frame, center upright frame and radiator (par. 28 **a**).

(2) Drain oil from engine and screw drain pipe from elbow on under side of oil pan.

(3) Remove exhaust tube and muffler.

(4) Remove the six nuts, lock washers, and bolts which attach engine and generator assembly to main frame.

(5) Remove rear fan cover from rear of generator.

(6) Attach a hoist to a chain looped around rear of generator (between exciter field support bracket and rear fan) and front of engine (between oil pan and front support bracket) (fig. 106). Lift hoist enough to take slack out of chain. Check chain position to be sure it will not damage engine accessories; especially distributor. Remove distributor cap if necessary to clear chain. Lift assembly from frame and lower onto blocks placed beneath generator mounting flanges and engine front support (fig. 107).

(7) Support engine with a hoist (fig. 108). Disassemble engine from generator (par. 81) and swing engine away from generator (fig. 109).

c. Removal of Engine Alone (figs. 110 and 111).

(1) Remove all four doors, all four side panels, hood, radiator (par. 28 **a**), and radiator base support.

(2) From carburetor, disconnect throttle control, choke control, and air intake elbow.

(3) Turn off gasoline at valve in tube near tank and disconnect tube from fuel pump.

(4) Disconnect "CG" wire from two-charge regulator.

(5) Disconnect terminal block to ignition coil wire from ignition coil.

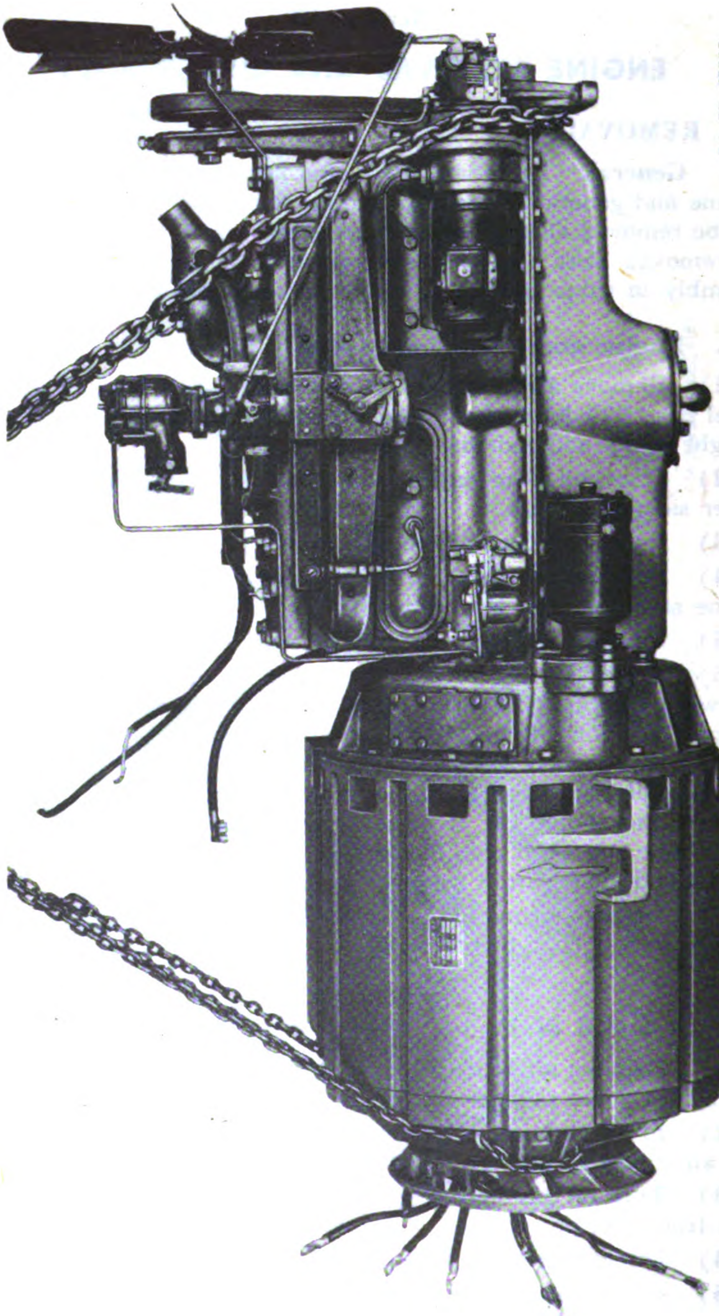


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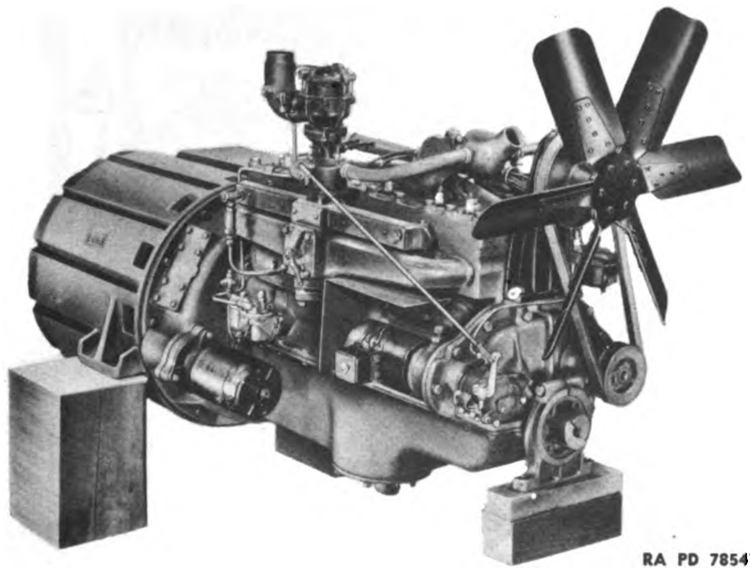
Figure 106—Method of Hoisting Engine and Generator Assembly



RA PD 78541

Figure 107—Method of Blocking Engine and Generator Assembly

(6) Remove exhaust tube and muffler (pars. 41 a and 42 a).

(7) Disconnect starting motor cable from each starting motor.

(8) Drain engine oil and screw oil drain pipe from elbow on under side of oil pan.

(9) Disconnect engine temperature gage bulb from left rear corner of cylinder head.

(10) Disconnect oil pressure gage tubing from base of oil filter.

(11) Support engine with a sling attached to a hoist and detach engine from generator (par. 81).

(12) Remove the two nuts, lock washers, and bolts which attach front engine support (fig. 92) to main frame.

(13) Swing engine forward to clear generator and hoist from unit. Lower engine into an engine stand or onto blocks placed under front engine support and each side of bell housing.

59. REMOVAL OF ACCESSORIES.

a. Remove following assemblies per instructions in TM 9-617: fan belt, fan and bracket, bayonet-type oil gage, thermostat with housing, bypass, water pump, carburetor, throttle body, manifold,

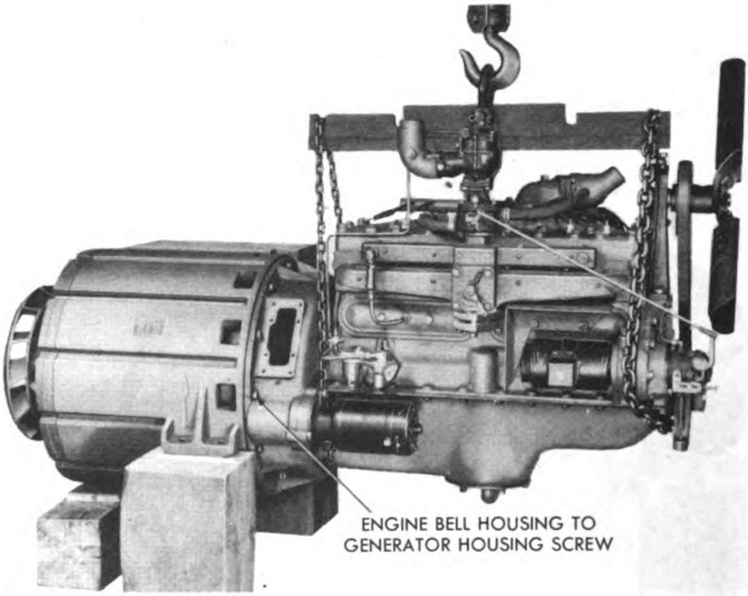


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Figure 108—Separating Engine From Generator (1)

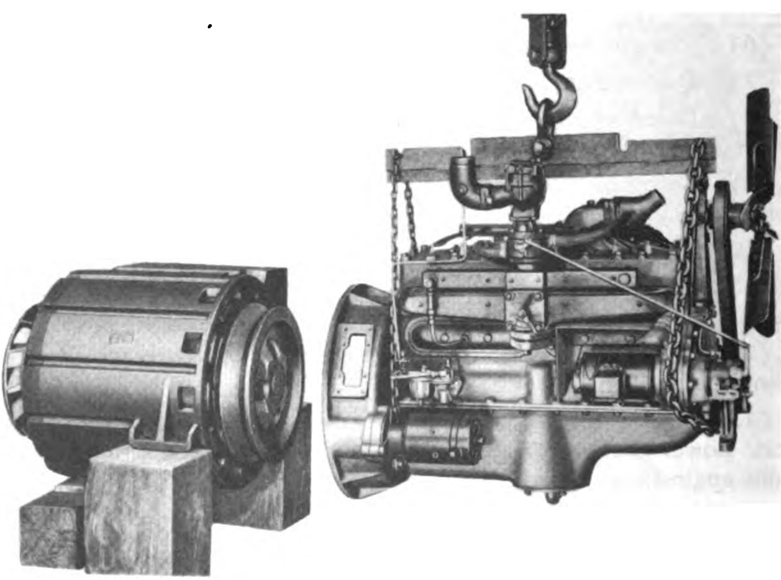

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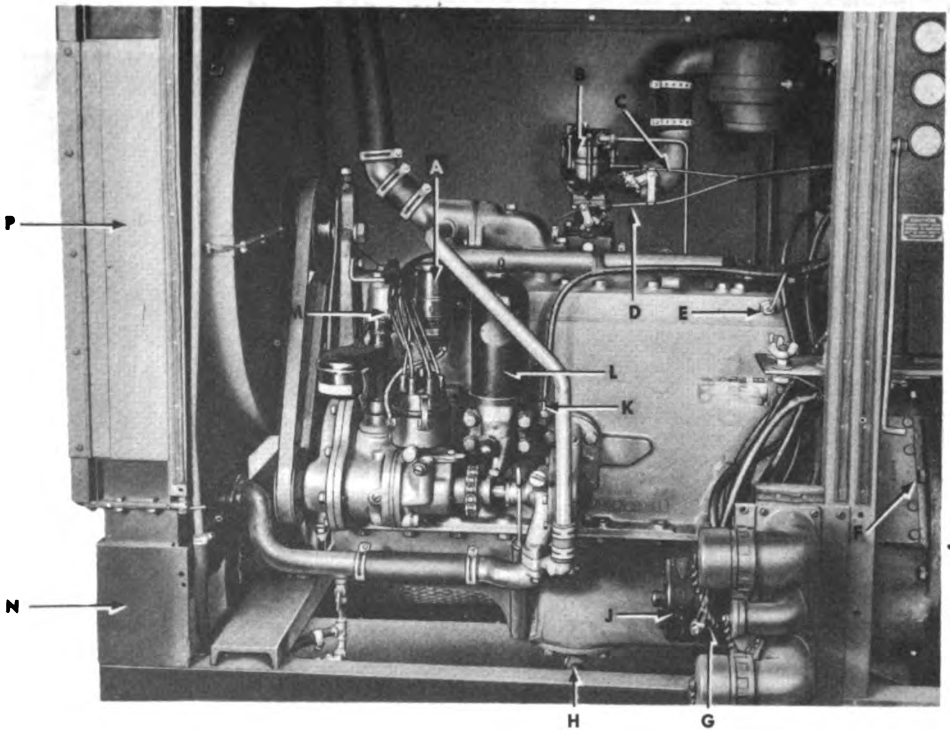
Figure 109—Separating Engine From Generator (2)



A—IGNITION COIL
B—CARBURETOR
C—CHOKE CONTROL
D—THROTTLE CONTROL
E—ENGINE TEMPERATURE GAGE BULB
F—BELL HOUSING TO GENERATOR HOUSING CAP SCREWS
G—CRANKING MOTOR CABLE
H—OIL DRAIN PIPE
J—CRANKING MOTOR
K—OIL PRESSURE GAGE TUBING
L—OIL FILTER
M—TERMINAL BLOCK TO IGNITION COIL WIRE
N—RADIATOR BASE SUPPORT
P—RADIATOR

RA PD 79567

Figure 110—Disconnection Points for Engine Removal—Left Side

A—AIR INTAKE ELBOW
B—CARBURETOR
C—"CG" WIRE
D—FRONT ENGINE SUPPORT
E—MAIN FRAME
F—TWO-CHARGE REGULATOR
G—MUFFLER
H—EXHAUST TUBE
J—FUEL PUMP
K—CRANKING MOTOR
L—CRANKING MOTOR CABLE

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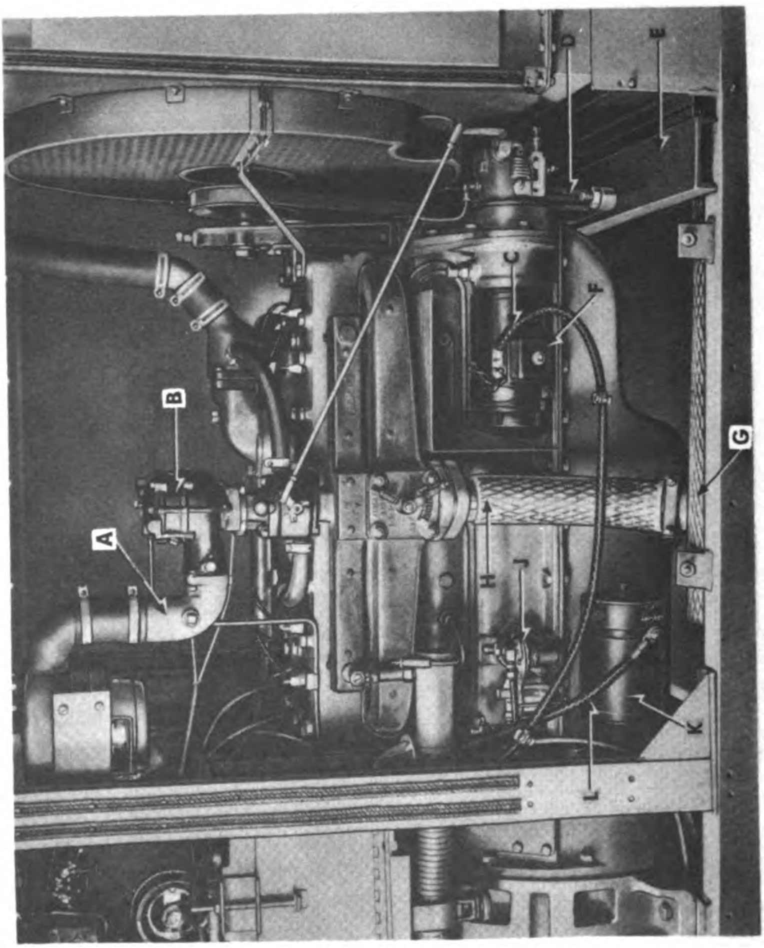


Figure 111—Disconnection Points for Engine Removal—Right Side

fuel pump, battery charging generator, spark plugs, ignition coil, and both starting motors (figs. 12 and 13).

b. Disconnect oil line from elbow on governor. Remove nut and disconnect governor linkage rod from governor. Remove the two cap screws and lock washers which secure governor to engine. Lift governor and gasket from engine (fig. 13).

c. Pull oil filler pipe and breather assembly from oil pipe adapter on water pump drive housing.

d. Remove distributor hold-down screw and lock washer, and loosen distributor clamp screw. Lift distributor from water pump drive (fig. 12).

e. Remove the two cylinder head cap screws which attach spark plug wire tube to head. Lift tube from head.

60. DISASSEMBLY.

a. Remove Subassemblies.

(1) Pull the two cotter pins which hold water pump drive shaft pulley drift pin in place. Drive drift pin from pulley and water pump drive shaft. Pull pulley from shaft and pull key from keyway in shaft (fig. 112).

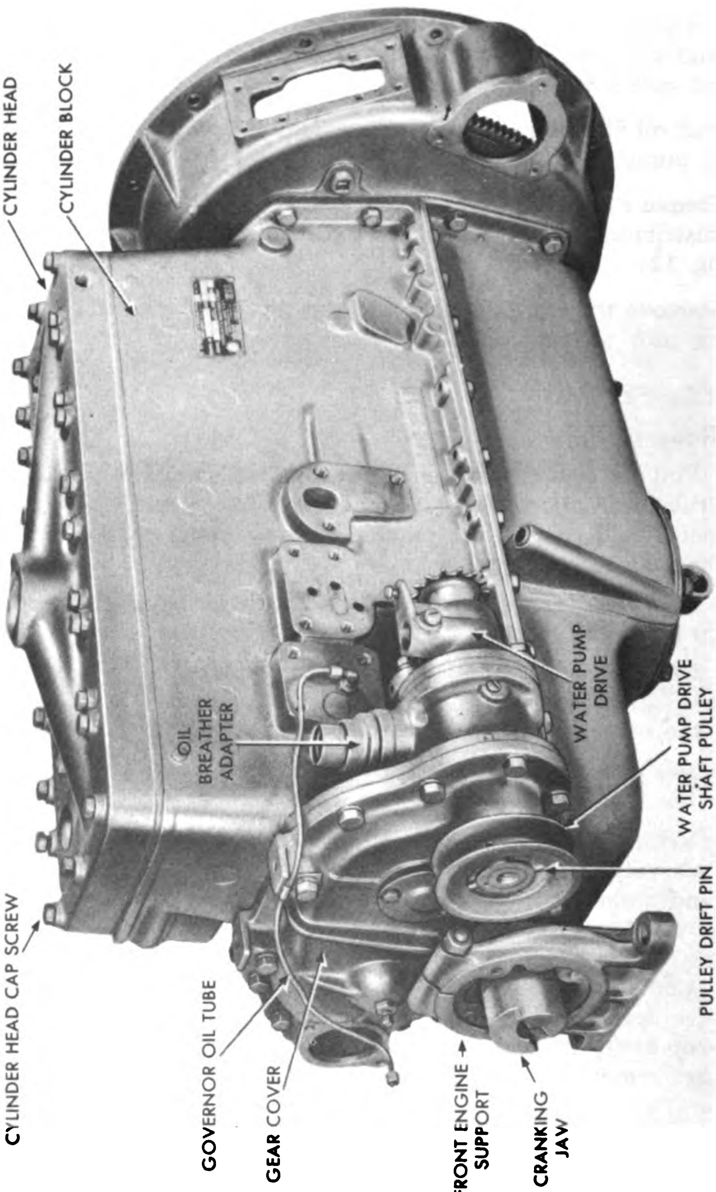
(2) Remove the three cap screws and lock washers which attach accessory pump drive housing and lift housing from engine (fig. 112).

(3) Only if necessary for repair or replacement, loosen oil breather adapter by holding a soft block against its lower lip and tapping the block with a hammer (fig. 112).

(4) Remove the 29 cap screws which attach cylinder head to cylinder block. Lift head and gasket from cylinder block (fig. 112).

(5) Remove the two screws and lock washers which secure each of the two valve chamber covers to cylinder block (fig. 113). Lift covers and gaskets from engine and plug holes in bottom of valve chamber with rags to prevent the loss of valve pins. Insert a valve spring lifter between a valve spring seat and valve tappet cluster casting. Compress spring and lock lifter. Pull valve spring seat pin from valve stem (fig. 114). Lift valve from top of cylinder block. Repeat the operation to remove the remaining 11 valves. Keep valves in order after removal to insure the return of each valve to its original location.

(6) Compress valve spring as much as possible with lifter. Insert screwdriver to hold valve spring under tension. Slide out lifter. Force valve spring and seat from chamber with screwdriver (fig. 115). Similarly remove remaining 11 valve springs and seats.



RA PD 78589

Figure 112—Engine With Accessories Removed—Left Front View

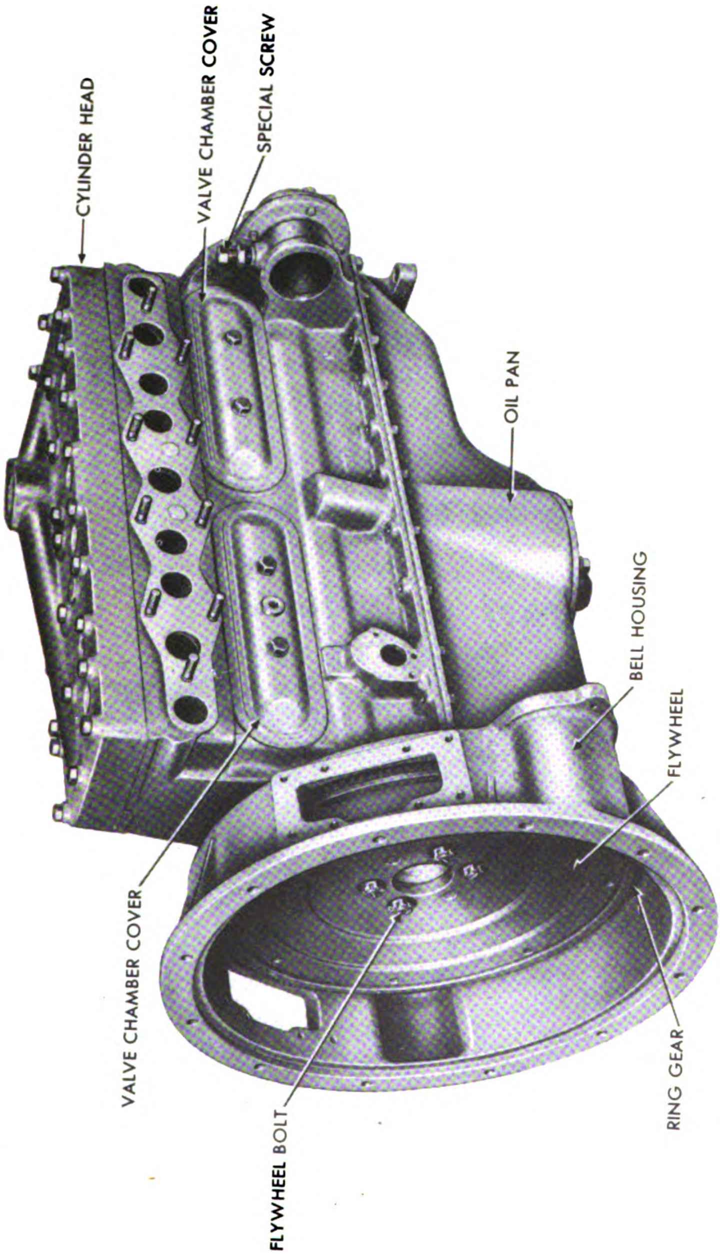


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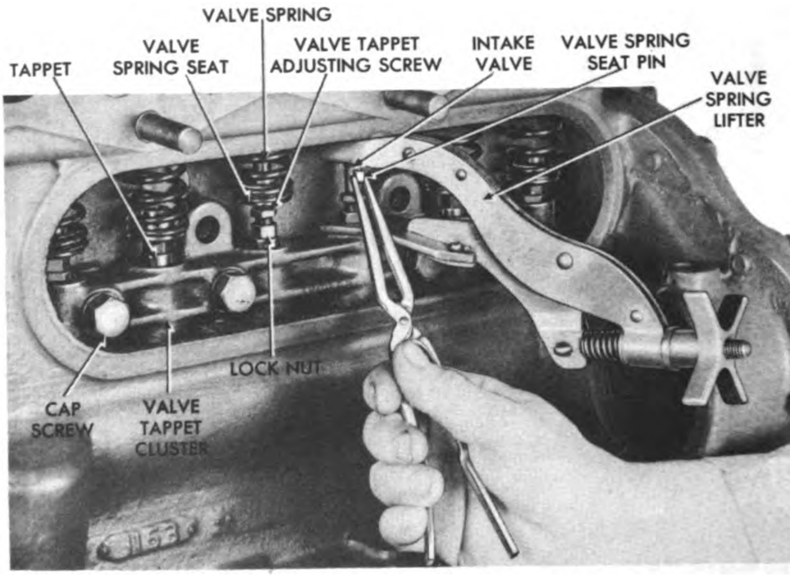
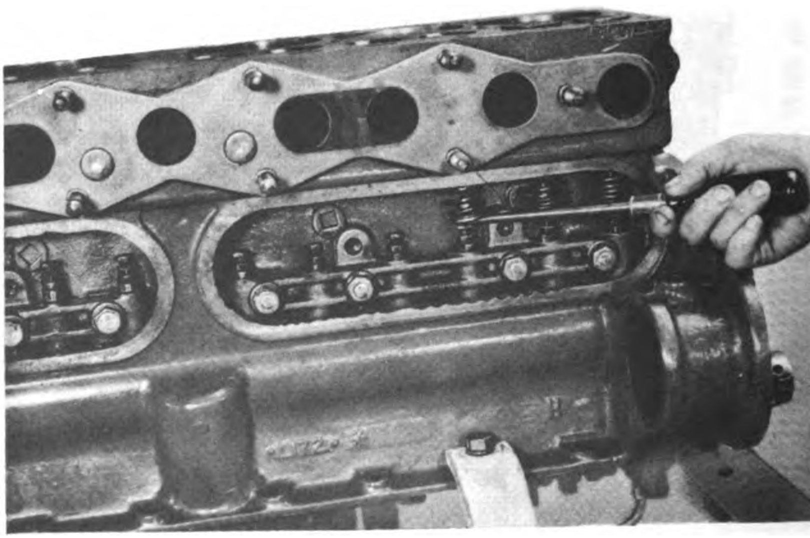
Figure 113—Engine With Accessories Removed—Right Rear View



RA PD 78601

Figure 114—Valve Removal



RA PD 70366

Figure 115—Valve Spring Removal

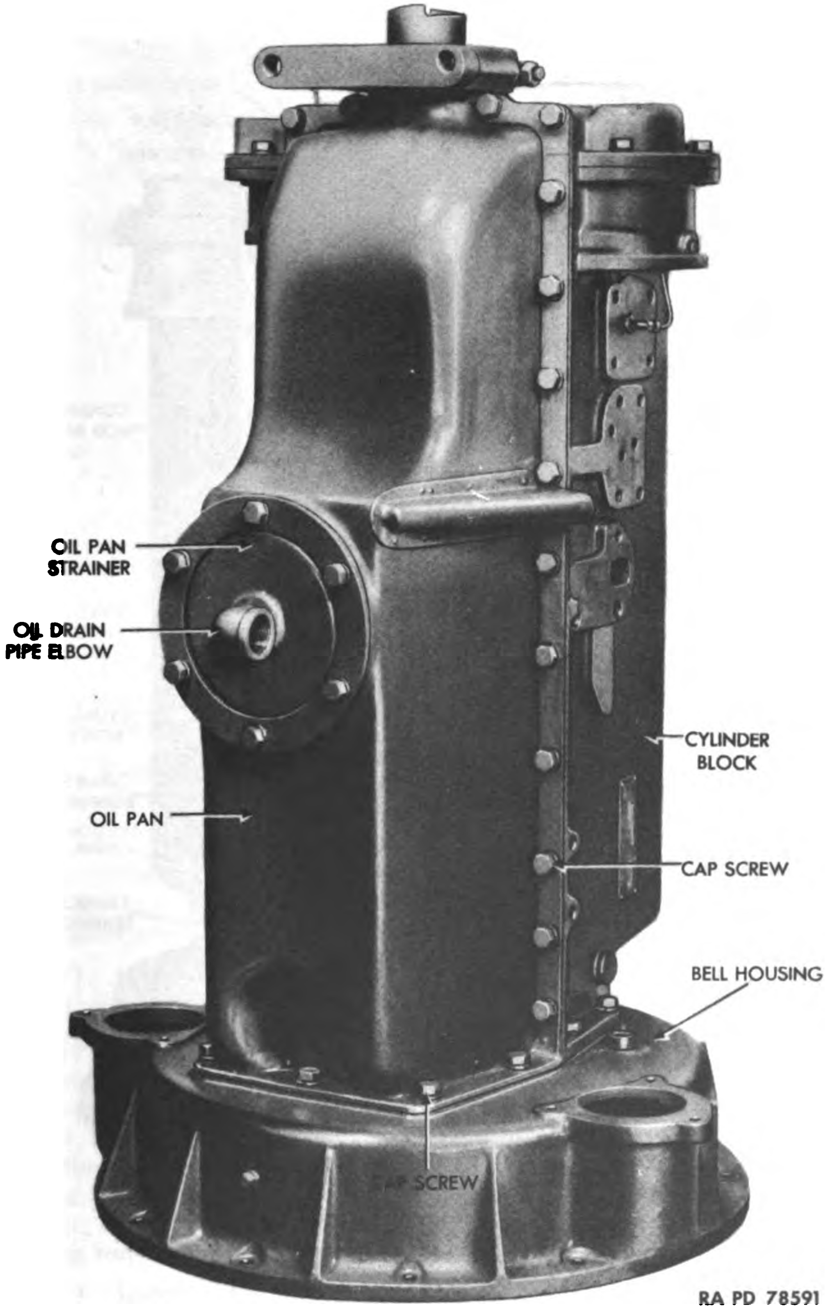


Figure 116—Engine With Accessories Removed—Underside View

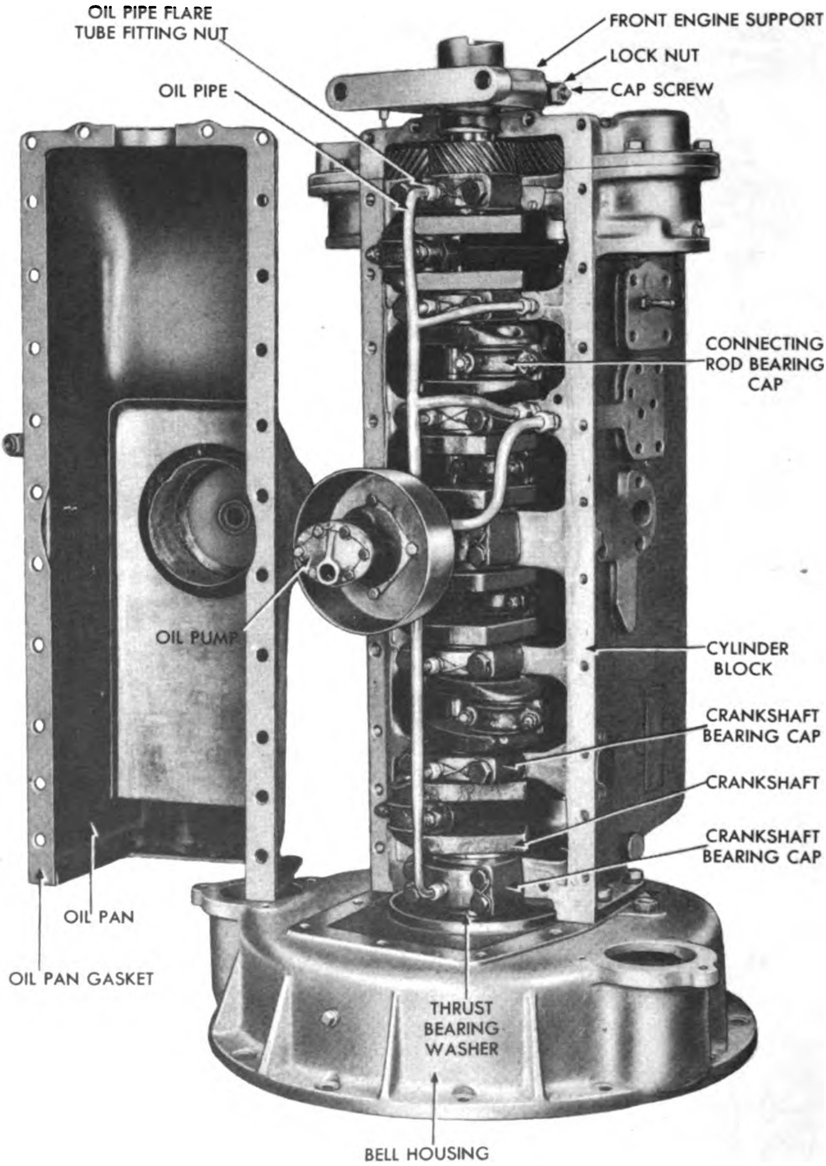


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Figure 117—Underside of Engine—Oil Pan Removed

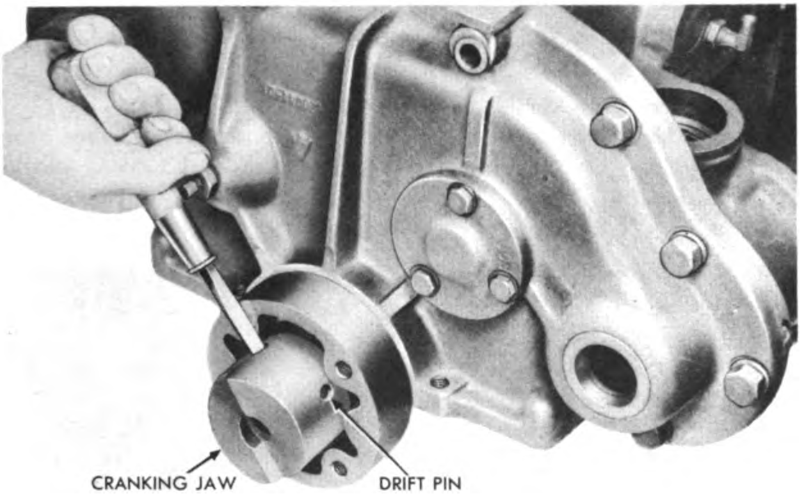

Figure 118—Cranking Jaw Drift Pin Set Screw Removal

(7) Remove the four cap screws and lock washers which attach each of the two valve tappet clusters (fig. 114) to cylinder block. Lift clusters from engine.

(8) Remove the 29 cap screws and lock washers which hold oil pan to cylinder block and bell housing (fig. 116). Lift pan and gasket from engine (fig. 117).

(9) Unscrew oil pipe sleeve nut from fitting on oil pump. Remove the four cap screws and lock washers which attach oil pump to cylinder block (fig. 55).

(10) Unscrew all oil pipe flare tube fitting nuts from fittings and lift oil pipe from engine (fig. 117).

(11) Pull cotter pins from castellated nuts on cap screws which hold connecting rod bearing caps in place. Remove nuts, shims, caps, and cap screws. Force connecting rod and piston assembly up through engine block. Rejoin connecting rod bearing cap to connecting rod with the shims returned to the position to facilitate the keeping of mating rod and shims (from which they were removed) and cap together. Repeat the procedure to remove the remaining five connecting rod and piston assemblies.

(12) Loosen lock nut on horizontal cap screw at top of front engine support (fig. 132). Loosen cap screw and slide support from engine.

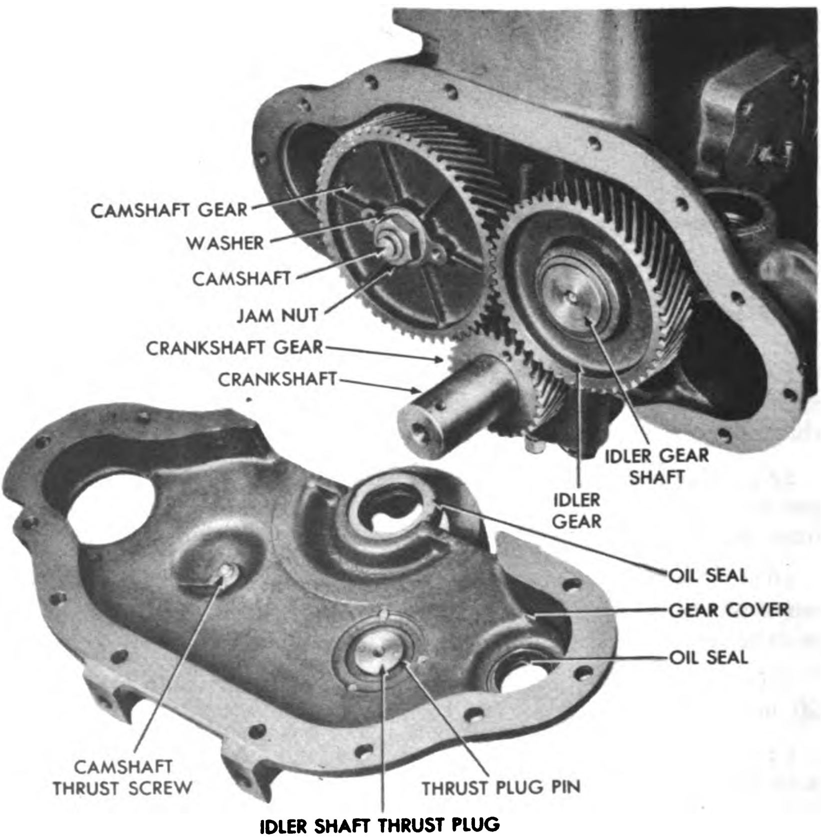

Figure 119—Front of Engine—Gear Cover Removed

(13) Remove set screw which holds drift pin through cranking jaw and crankshaft at front end of crankshaft (fig. 118). Drive pin from jaw and shaft. Pull jaw from shaft.

(14) Remove the 10 cap screws and lock washers which attach gear cover to front end of cylinder block. Lift cover and gasket from block. Do not lose oil seal (fig. 119).

(15) Screw governor oil tube nut from fitting on left side of cylinder block. Lift tube from engine (fig. 112).

(16) Lift idler gear and shaft from front end of cylinder block. Slide camshaft and gear assembly from front end of cylinder block. Use care to keep from injuring bearings with cams.

(17) Pull cotter pins which safety the four castellated nuts to flywheel studs on rear end of crankshaft (fig. 113). Remove castellated nuts. Lift flywheel from crankshaft. To facilitate removal, pry on flywheel or place wooden block against flywheel through openings in front of bell housing and drive flywheel from crankshaft.

(18) Cut and pull wires from each pair of crankshaft main bearing cap screw heads. Remove cap screws. Lift bearing caps, shells, and shims from cylinder block. Mark back of each shell with number corresponding to that on its cap so that it will be reassembled in the same order, provided no new shell is required.

(19) Carefully pry brass thrust bearing washer sections from between end flange on flywheel and engine block (fig. 117).

(20) Remove the six cap screws and lock washers (two inside bell housing, four outside bell housing) which attach bell housing to cylinder block. Lift bell housing from cylinder block.

(21) Lift crankshaft from cylinder block.

(22) By hand, push down on one end of each crankshaft upper bearing shell until it rotates in bearing web enough to get fingers under shell. Lift shells from cylinder block. Mark each shell on its back with a number corresponding to its position in cylinder block. This will insure assembly in original position, provided no new shell is required.

b. Disassemble Water Pump Drive (fig. 120).

(1) Drive taper pin from coupling sprocket and shaft. Press sprocket from rear end of shaft. Pull key from keyway in shaft.

(2) Slide housing from rear end of shaft. Press oil seal from housing.

(3) Straighten special washer and remove lock nut from rear end of shaft. Slide washer from shaft. Remove gear retaining nut from shaft.

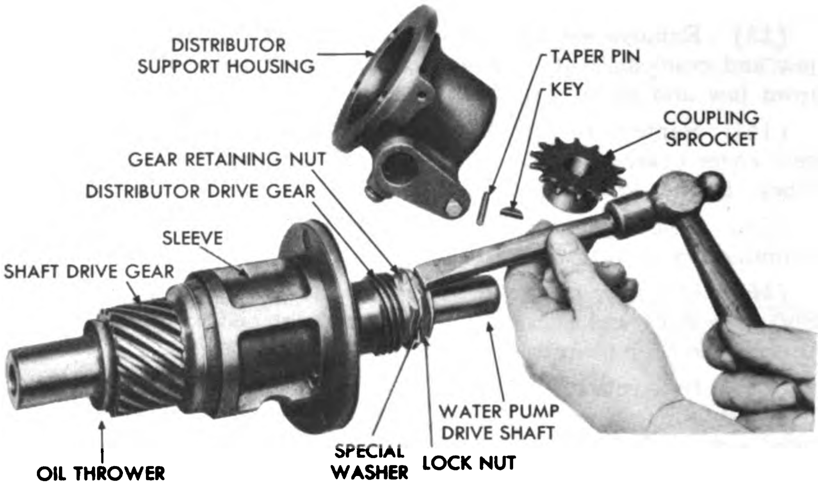

Figure 120—Water Pump Drive Disassembly

(4) Slide or press distributor drive gear and thrust washer from rear end of shaft. Pull key from keyway in shaft.

(5) Slide sleeve and thrust washer from rear end of shaft and press bushing from sleeve.

(6) Press oil thrower and shaft drive gear from front end of shaft. Pull key from keyway in shaft.

c. **Disassemble Valve Tappet Cluster** (fig. 114). Pull tappets from bottom of clusters. Loosen lock nut on each valve tappet adjusting screw. Remove screws from tappets. Screw nuts from screws.

d. **Disassemble Oil Pan** (fig. 116). Remove the six screws and lock washers which attach oil pan strainer to oil pan. Lift strainer and gasket from pan. Screw elbow from strainer.

e. **Disassemble Oil Pump.** Refer to paragraph 47 b.

f. **Disassemble Connecting Rod and Piston Assembly** (fig. 133).

(1) Expand the top compression ring and slide it from the top of the piston. Similarly remove the two remaining compression rings and one oil ring.

(2) Remove piston pin retaining screws and lock washers. Tap pin from piston and connecting rod. Lift rod from piston.

g. **Disassemble Gear Cover** (fig. 119).

(1) Slide oil seal from its seat on under side of gear cover.

(2) Remove the three cap screws and lock washers which attach idler shaft thrust plug plate to gear cover. Lift plate and shims from cover. Pull plug and two thrust plug pins from plate.

(3) Loosen lock nut on camshaft thrust screw. Remove screw from gear cover. Screw lock nut from screw.

h. Remove Gear From Camshaft (fig. 119).

(1) Remove jam nut and washer from front end of camshaft.

(2) Press shaft from gear. Pull key from keyway in shaft.

i. Remove Idler Gear From Shaft (fig. 119).

(1) Slide thrust washer from shaft.

(2) Press shaft from gear. Pull key from keyway in shaft.

Section X

INSPECTION OF DISASSEMBLED ENGINE

61. ENGINE COMPONENT CLEANING.

a. Soak all aluminum parts in dry-cleaning solvent. Dry with a clean cloth. Soak all steel parts in dry-cleaning solvent. Leave them only long enough to dissolve all grease and dirt. Blow solvent from passages with compressed air and wipe parts dry with a clean cloth.

b. Clean carbon from piston ring grooves with piston ring groove cleaner or with a broken piston ring ground flat on the end.

c. Clean cylinder block with grease-cleaning compound and rinse with clean water.

d. Strip all gaskets from machined surfaces where sealing compound has been used. Clean the surfaces by scraping and washing them with dry-cleaning solvent.

62. CYLINDER BLOCK AND CYLINDER HEAD INSPECTION.

a. Cylinder Head.

(1) Examine cylinder head to see if it is cracked.

(2) Inspect machined face of cylinder head for nicks or scratches serious enough to allow water or compression leakage. Place straightedge across machined surface of cylinder head and check for a warped head (fig. 121).

(3) Examine threads tapped in spark plug holes to see if they are burred or stripped.

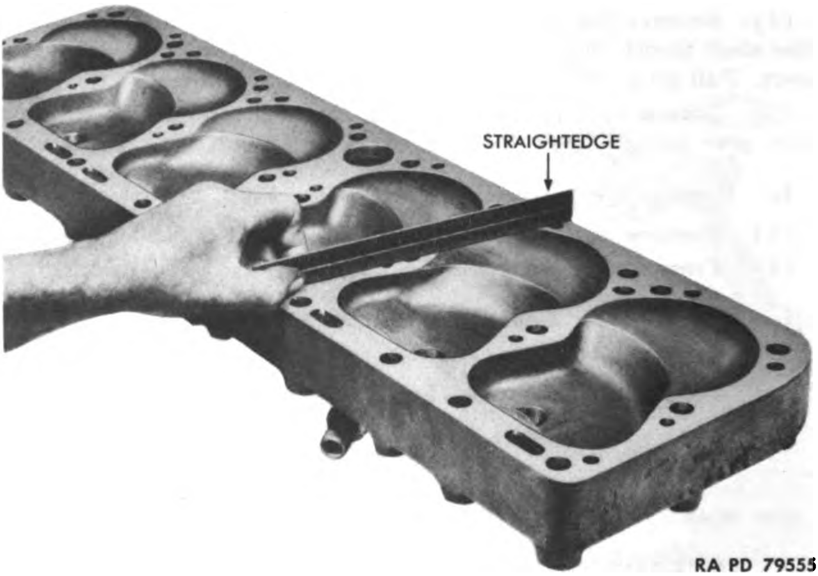

Figure 121—Testing Cylinder Head for Warping

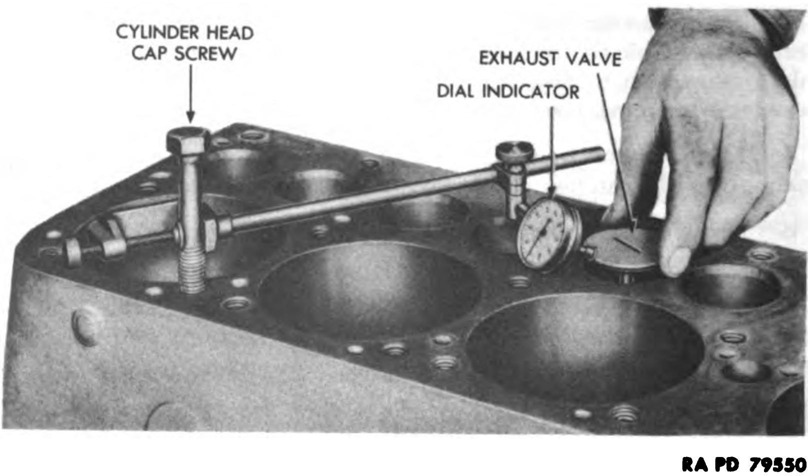

Figure 122—Measuring Valve to Valve Guide Clearance

(4) Inspect all cylinder head cap screws to see if they are bent, broken, burred, or stripped.

b. **Cylinder Block.** Inspect cylinder block for cracks especially between valve seats and cylinder.

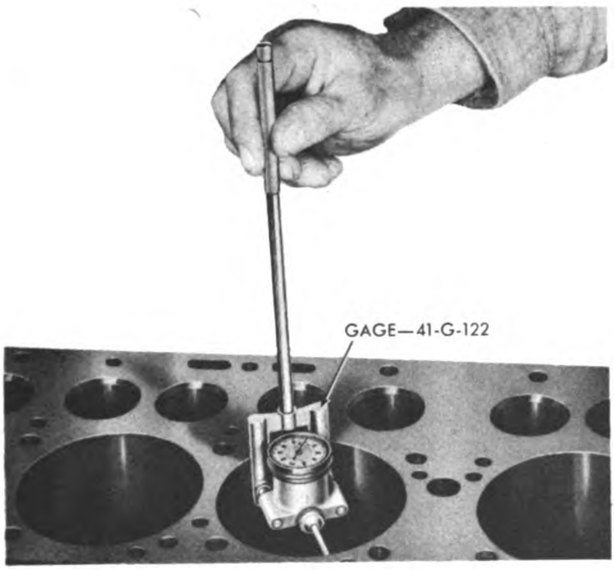

Figure 123—Checking Cylinder Bore Wear

c. Inspect all studs to see if they are bent, broken, burred, or stripped. Test cylinders for excessive taper and out-of-round with the dial indicator.

d. Clean the interior of the valve stem guide with a wire brush and solvent. Place the valve in the guide with the head of the valve five-sixteenths inch above the cylinder block. Attach a dial indicator to a cylinder head cap screw installed in a convenient screw hole in the cylinder block and adjust the plunger of the indicator against the edge of the valve head. Hold the valve so that it will not turn, and move it toward and away from the indicator and note the amount of play shown on the dial (fig. 122). The clearance between the valve stem and guide will be one-half of the amount shown on the indicator. The amount of wear in the guide would be the clearance less the wear of the valve stem. If an intake valve stem guide is worn more than 0.005 inch, or an exhaust valve stem guide is worn more than 0.007 inch, replace the guide.

e. Slide idler shaft into idler shaft bearing and test side play. If side play is more than barely perceptible, bearing is worn.

f. Slide camshaft into position in camshaft bearing. Measure

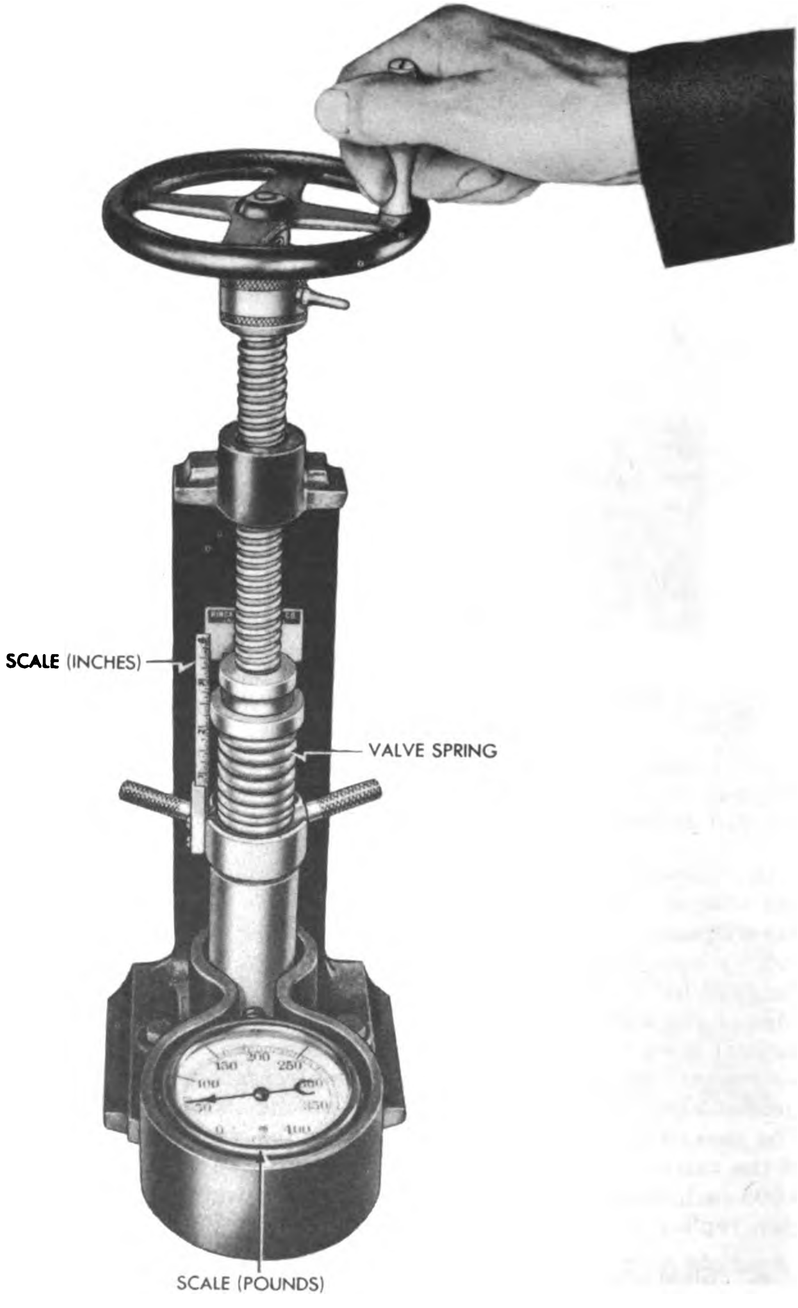

Figure 124—Testing Valve Spring Tension

clearances between bearings and journals with a feeler gage. Clearances in excess of 0.003 inch indicates worn bearings.

g. Notice condition of all threads tapped in stud and screw holes to see if they are burred or stripped.

h. Inspect all expansion plugs for looseness or leakage. Discoloration around the plug indicates leakage.

i. Examine valve seats to see if they are pitted, burned, or eccentric.

j. Run a dial indicator up, down, and around each cylinder. Note if readings vary as much as 0.003 to 0.005 inch, indicating taper or out-of-round (fig. 123).

63. VALVES AND VALVE OPERATING MECHANISM INSPECTION.

a. **Inspect Valves.**

(1) Examine valve faces to see if they are warped, pitted, cracked, or burned.

(2) Examine valve stems to see if they are bent or scored. Insert stems into guides and test side play. Presence of more than barely perceptible side play indicates wear.

(3) Examine valve springs, spring seats, and spring seat pins to see if any of them are bent, broken, or noticeably worn. Measure free length of springs. The measurement should be $3^{11}/_{16}$ inches. Test tension of springs to see if they are within the allowable limits of 47 to 53 pounds at $2^{3}/_{4}$ inches (fig. 124).

b. **Inspect Valve Tappets.**

(1) Examine faces of valve tappets for evidences of scoring.

(2) Examine valve tappet adjusting screws and lock nuts to see if they are bent, broken, burred, or scored.

(3) Examine female threads in valve tappet stem to see if they are burred or stripped.

(4) Insert tappets into their respective holes in clusters and test side play. More than a barely perceptible side play indicates a worn tappet or cluster.

(5) Examine valve tappet cluster to see if the casting is cracked or broken.

(6) Inspect cluster cap screws and lock washers to see if they are bent, broken, or burred. Note condition of threads on screws.

c. **Inspect Camshaft.**

(1) Inspect cams and journals for score marks.

(2) Examine thrust washer to see if it is worn or scored.

(3) Examine camshaft gear and oil pump drive gear to see if either gear has chipped, worn, or broken teeth.

(4) Examine threads on front end of shaft to see if they are burred or otherwise damaged.

(5) Examine keyway to see if it is burred or spread.

(6) Examine key, washer, and nut to see if they are bent, broken, or burred. Note condition of threads in nut.

64. PISTON AND CONNECTING ROD INSPECTION.

a. Connecting Rod.

(1) Examine connecting rod bearing for score marks, or broken, chipped, or burned metal.

(2) Inspect threads on connecting rod cap bolts, nuts, and piston pin lock screw to see if they are burred or stripped.

(3) Test assembled connecting rod and piston for bend and twist (par. 70 e).

b. Piston.

(1) Test fit of piston pin in piston pin bushing by attempting to rock the assembled connecting rod sidewise in the piston. Presence of side play indicates a worn piston or pin or both. NOTE: *Do not confuse endwise motion of pin in its bosses for side play.*

(2) Carefully examine piston for score marks.

(3) Inspect all piston rings to see if they are broken. Measure clearance of rings in piston ring groove with a feeler gage. A maximum of 0.0025 inch is permissible. Place piston rings in running position in cylinder. Measure clearance of end gap with a feeler gage. Safe maximum end gap is 0.020 inch.

65. WATER PUMP DRIVE INSPECTION.

a. Inspect housing and sleeve to see if either of these castings is cracked.

b. Examine all machined surfaces to see if any are burred or scored. Inspect teeth of all gears to see if they are pitted, nicked, chipped, or noticeably worn.

c. Slide shaft into bushing and measure clearance with a feeler gage. A maximum of 0.002-inch side play is permissible.

d. Examine key, washers, and nuts to see if they are bent, broken, scored, burred or noticeably worn. Note condition of threads on threaded parts.

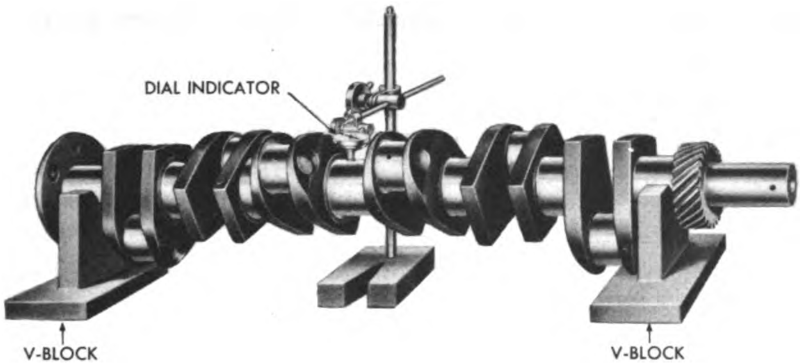

Figure 125—Checking Crankshaft for Run-out

66. CRANKSHAFT AND CRANKSHAFT BEARING INSPECTION.

a. Crankshaft.

(1) Examine teeth of crankshaft gear to see if they are worn or broken.

(2) Examine bearing journals for evidence of scoring or burning.

(3) Blow compressed air through oil passages to test for obstructions.

(4) Measure diameter of each bearing journal at intervals with a micrometer. If sides of any journal varies more than 0.003 inch, the journal is seriously out-of-round.

(5) Revolve crankshaft in a lathe or V-block. Place a dial indicator against center main bearing journal (fig. 125). If readings show more than 0.002-inch run-out as crankshaft rotates, crankshaft is bent. NOTE: *This test can not be made if crankshaft has out-of-round journals* (step (4), above).

b. Crankshaft Bearings.

(1) Examine bearings to see if they are scored, burned, or broken.

(2) Inspect main bearing screws, caps, and shims to see if they are bent, broken, chipped, or burred. Note condition of threads on screw.

67. REMAINING ENGINE COMPONENTS, INSPECTION.

a. Fan Drive Pulley. Examine pulley and pin to see if they are broken or noticeably worn.

b. Engine Front Support Bracket. Inspect bracket to see if it is cracked.

c. Oil Pan.

(1) Examine oil pan for dents or cracks.

(2) Examine strainer screen to see if it is bent, torn, or fouled.

(3) Inspect screws and washers to see if they are bent, broken, or have damaged threads.

(4) Inspect threads on oil drain pipe assembly and in oil pan strainer drain pipe opening.

d. Gear Cover.

(1) Inspect gear cover to see if it is broken or if machined surfaces are nicked or burred.

(2) Examine oil seals to see if they are worn or otherwise damaged.

(3) Examine thrust plug, pins, plate, and shims to see if any of them are broken, bent, burred, nicked, or noticeably worn.

(4) Inspect all screws, washers, and nuts to see if they are bent, broken, burred or stripped.

e. Inspect Idler Shaft Assembly.

(1) Examine teeth of gear to see if they are nicked, chipped, pitted, or noticeably worn.

(2) Inspect keyway in shaft and gear to see if they are spread.

(3) Inspect thrust washer for wear.

(4) Inspect shaft to see if it is scored.

(5) Test fit of shaft in bushing. Noticeable side play indicates a worn bushing.

f. Inspect Flywheel.

(1) Examine flywheel to see if it is cracked.

(2) Test fit of dowel pins in pinholes. They should be a drive fit.

(3) Examine threads in the eight a-c generator front fan attaching screw holes to see if they are burred or stripped.

(4) Inspect teeth of ring gear to see if they are chipped, broken, or worn.

g. Bell Housing.

(1) Inspect bell housing to see if it is cracked or broken.

(2) Note condition of threads in all tapped holes.

(3) Inspect all cap screws and lock washers to see if they are bent, broken, or stripped.

ENGINE AND ACCESSORIES

Section XI

ENGINE REPAIR

68. CYLINDER BLOCK AND CYLINDER HEAD REPAIRS.

a. Cracked Cylinder Block or Head. Replace broken castings. In event a new part is unavailable, a casting cracked externally can be temporarily repaired, usually by welding.

b. Leaking Expansion Plugs. Drive a sharp punch through the leaking plug and pry from cylinder block. Scrape all dirt from seat in cylinder block. Coat new plug with joint-and-thread cement compound and drive to seat with soft block and hammer.

c. Damaged Female Threads. Remove burs with a thread tap. Correct stripped threads by filling hole with metal by welding. Drill hole to correct size and cut new threads with a thread tap.

d. Studs or Screws Twisted Off in Cylinder Block. If broken above surface, remove broken part with a stud remover. If broken flush with or below surface, drill stump and remove with a screw extractor.

e. Machined Surface Nicked or Scratched Seriously. Unless damage permits leakage of water, compression, or oil, no correction is necessary. If leakage is present, replace damaged part or true up surface on a milling machine. Take as light a cut as possible, especially when repairing machined surface of cylinder block or cylinder head. If necessary to take a deep cut, use two gaskets to keep from altering compression appreciably.

f. Cylinder Walls Worn or Scored.

(1) GENERAL. Damaged cylinder walls are normally repaired by reboring and then honing. Cylinders only slightly tapered, out-of-round, or scored can be corrected by honing alone. Cylinders worn 0.005 inch or more should be rebored before honing.

(2) REBORING. Clean surface of top of cylinder block with a mill file. Position boring bar over cylinder and secure it to cylinder block with cylinder head cap screws. Center bar over cylinder and adjust cutting tools to size the cylinder is to be cut. This depends upon the size piston is to be fitted (par. 70 **d**) and amount of wear or depth of score marks. Start boring-bar motor and engage cutting tool. Stop motor as soon as cutting tool has cut the entire length of the cylinder bore. Return cutting tool to top of cylinder block and detach boring bar from cylinder block. Similarly rebore remaining five cylinders.

(3) HONING. Two types of hones are in common use—wet and dry. Each consists of a grinding tool which is revolved in the cylinder

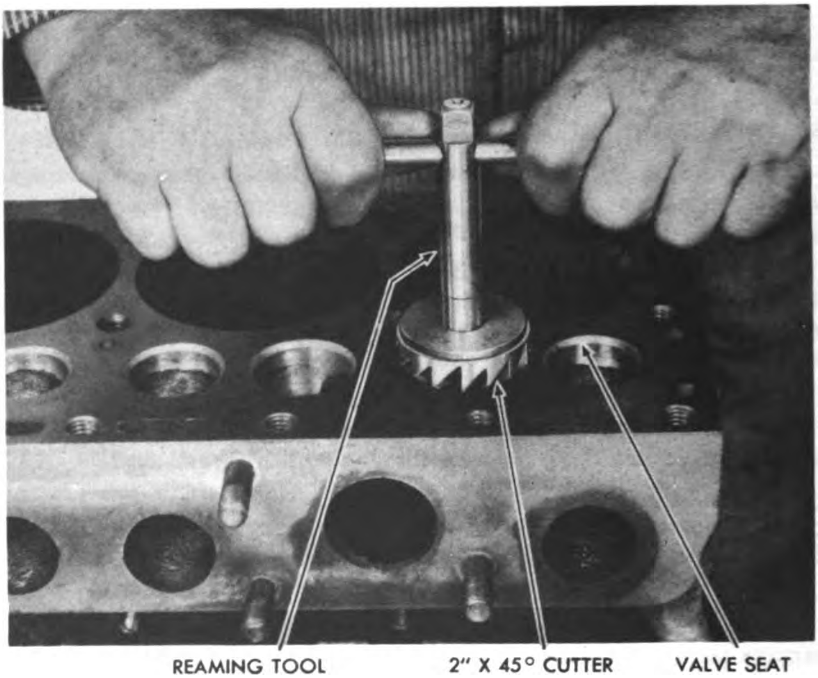

Figure 126—Reaming a Valve Seat

by an electric motor. In a wet hone, cylinder wall is lubricated with Diesel fuel oil during the operation. No lubricant is used for a dry hone, but vacuum dust collecting equipment is set up under cylinder block. Place hone in position in cylinder and adjust rough cutting stones to cylinder size. Start hone motor and move hone slowly up and down as it revolves in cylinder. Hone high spots first. Then hone up and down full length of bore. Remove hone and install polishing stones and hone until piston fits with proper clearance (par. 70 d).

g. **Valve Guides Worn.** Using a pilot which fits the valve guide properly, drive valve guide from cylinder block. Position new valve guide on top of guide hole. Using proper fitting pilot, press guide into position with top of guide $^{29}/_{32}$ inch below machine surface of block. Ream new valve guide with a straight fluted reamer to obtain 0.001- to 0.0015-inch clearance for the valve stem.

h. **Valve Seats Pitted, Burned, Scored, or Eccentric.** Refinish seat with a 45-degree valve seat reaming tool (fig. 126). Use seat tools with $^3/_8$-inch diameter pilots. Continue process until each seat has an even width of $^1/_8$ to $^5/_{32}$ inch all the way around its circumference.

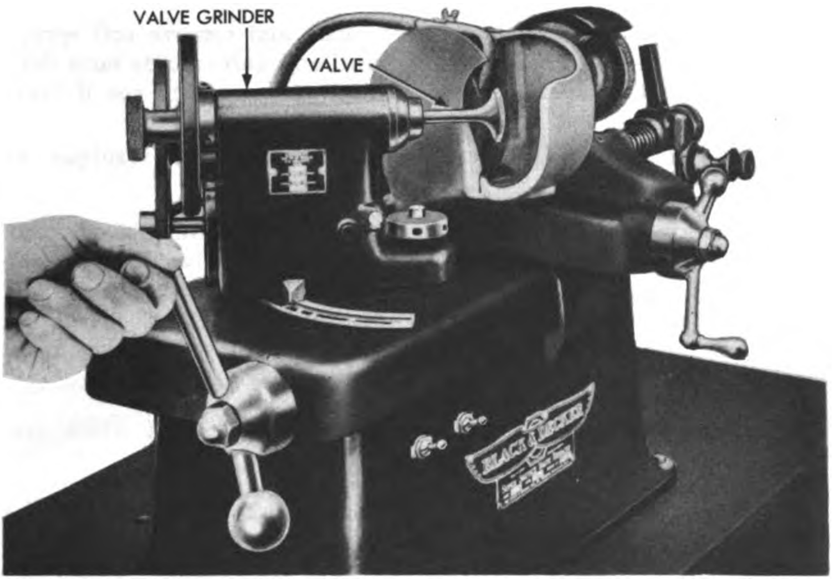

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Figure 127—Refacing a Valve

If exhaust valve inserts are worn enough to cause seat tool to cut into metal of cylinder block, remove insert with a cold chisel and hammer. Pack new insert in dry ice for several minutes to shrink it. Remove insert from dry ice and quickly place it in position in cylinder block. If necessary, use a brass block and hammer to tap it to seat.

69. VALVES AND VALVE OPERATING MECHANISM REPAIR.

a. **General.** Replace valves if warped, cracked, burned, badly pitted, or if valve stems are worn. Replace worn or damaged valve spring, spring seats, and spring seat pins. Replace weak springs.

b. **Refacing Valves.** Reface valves if slightly pitted or slightly scored. Set valve facing angle at 45 degrees.

c. **Reconditioning Valve Seats.** Refer to paragraph 68 h.

d. **Lapping Valves.** After resurfacing valve seats and refacing valve, lap valves to seat as follows:

(1) Spread fine valve-grinding compound sparingly on face of valve. Insert valve through a light coil spring just long enough to hold valve clear of cylinder block.

(2) Place valve stem into its guide. Force valve down on its seat and rotate valve back and forth several times.

(3) Remove valve from cylinder block and remove coil spring from valve stem. Wash valve, valve seat, and valve guide with dry-cleaning solvent. Inspect valve face and valve seat to see if both have a bright polished appearance.

(4) Similarly lap other valves and test valve seat (subpar. e, below).

e. **Testing Valve Seat.** Place pencil marks at intervals around face of valve and insert valve into its guide. Press valve down to seat and turn valve a half turn. Remove valve and inspect face. If all pencil marks are rubbed out, fit is satisfactory. If pencil marks remain, repeat lapping and testing operation until satisfactory fit is obtained.

f. **Repairing Valve Tappets.** Smooth tappet faces which are lightly scored with a honing stone.

g. **Repair Camshaft.** Replace camshaft if cam faces are badly scored; if oil pump drive gear is chipped or worn, or if camshaft is sprung; or if bearing journals are scored. Replace camshaft gear if nicked or worn. Hone light score marks from cam faces with a stone.

70. PISTON AND CONNECTING ROD REPAIRS.

a. **General.** Replace connecting rod bearings if scored, broken, chipped, burned, or worn. Replace all damaged connecting rod cap bolts, nuts, piston pin lock screws, and washers. Replace worn piston rings. Replace scored, worn, or out-of-round pistons. Install oversize pistons whenever cylinder walls are resurfaced.

b. **Fitting Piston Rings.**

(1) Installation of piston rings will correct oil pumping and loss of compression past piston, provided the piston and cylinder walls are not damaged or worn excessively. If cylinder wall wear exceeds 0.005 inch, reface cylinder walls and fit oversize pistons. If cylinder wall wear is 0.003 to 0.005 inch, install oversize piston rings. If cylinder wall is less than 0.003 inch, install standard size piston rings. Measure cylinder wall with a dial indicator to determine the amount of wear. Inspect tops of cylinder bores. If walls are worn, an unworn portion at the top of the cylinder will appear as a narrow ridge. Remove ridge with a ridge remover.

(2) Slip piston ring into cylinder in running position. Measure end gap with a feeler gage. If end gap exceeds 0.020, use an oversize ring. If end gap is less than 0.015 inch, file ends of ring on a mill file secured on holding fixture to obtain that clearance. Fit each ring to the piston in which it is to be used.

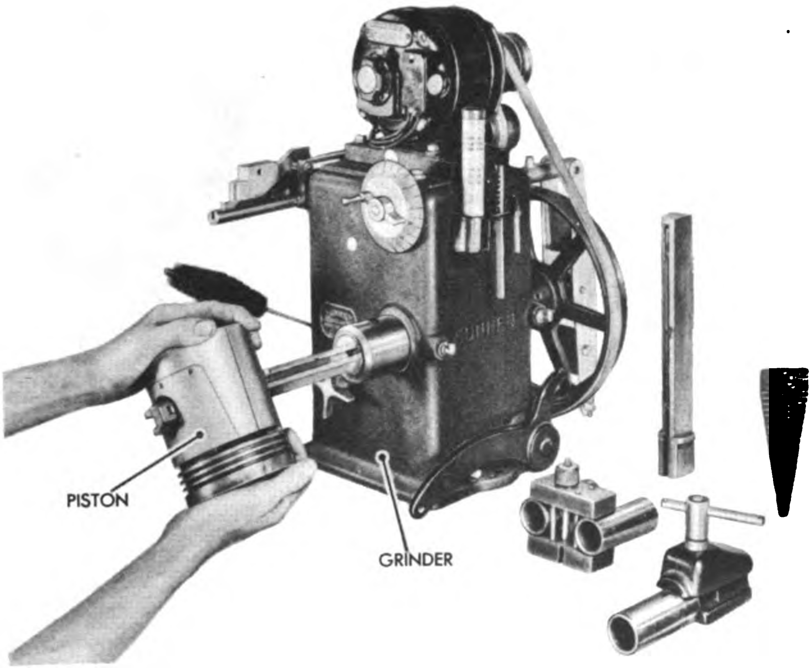

Figure 128—Honing a Piston Pin Boss

(3) Examine ring grooves in each piston. Remove carbon with a ring groove cleaner or a portion of a broken piston ring. Carefully remove burs with a fine mill file. Clean carbon from oil return hole in oil ring groove.

(4) Install rings in proper grooves in pistons: oil ring (slotted ring) belongs in bottom groove of each piston, and compression rings (rings without slots) go in three upper grooves in each piston. Measure clearance of each ring in its groove between edge of ring and piston. Proper clearance is 0.001 to 0.0025 inch. If clearance is under 0.001 inch, remove ring and lap it on crocus cloth, shellacked to a flat surface, until proper clearance is obtained. If clearance exceeds 0.0025 inch, use a new piston ring, piston, or both.

c. **Fitting Piston Pins.** Attempt to insert piston pin into its bearing surfaces in piston. If impossible to insert piston pin, take a light cut from piston pin boss with a hone (fig. 128) and again attempt to insert pin. Repeat the operation until light push is obtained. If pin fits too loosely, replace piston.

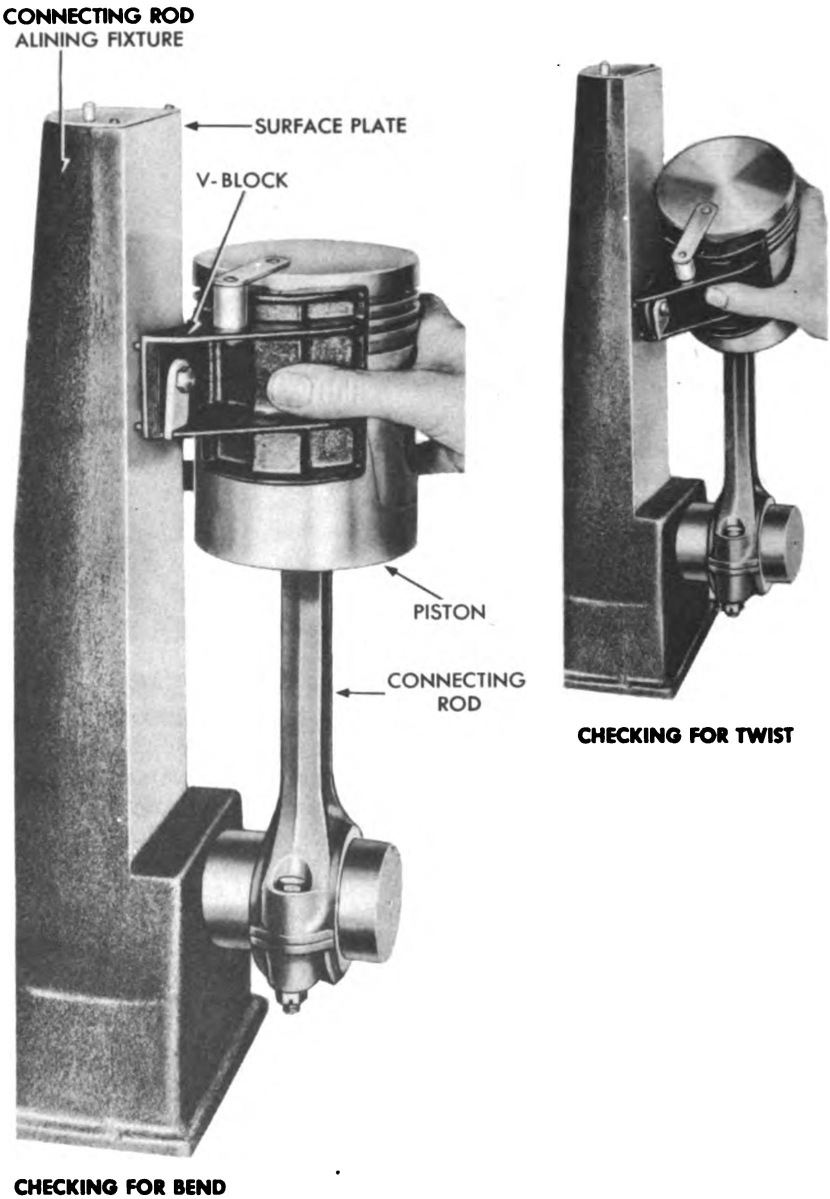

Figure 129—Connecting Rod Alinement Tests

d. Fitting Pistons. Oversize pistons must be fitted to cylinder after refacing cylinder walls. Pistons are fitted with rings and connecting rod removed from piston. Insert end of a 0.0025-inch feeler gage ribbon into top of cylinder on thrust side (right-hand side when viewed from rear of engine) of cylinder. Push piston into cylinder, upside down, with feeler gage between cylinder wall and piston. Be sure piston is turned so piston pin bosses determine a line parallel with centerline of crankshaft. Pull on protruding end of feeler gage ribbon. It should pull out with a slight pull. If it binds, hone cylinder wall to provide additional clearance. If it pulls out without resistance, replace piston with a larger oversize and repeat operation.

e. Alining Connecting Rods (fig. 129).

(1) Clamp assembled connecting rod and piston, without piston rings, onto a connecting rod alining fixture. With piston upright on connecting rod, hold V-block against piston and surface plate. If pins on V-block both touch surface plate, connecting rod is straight. If only one pin touches surface plate, connecting rod is bent. Slide a bending rod onto bent connecting rod and bend until straight.

(2) After straightening connecting rod, cock the piston to one side as far as it will go. Place V-block against piston and surface plate. Slowly tip piston as far as it will go in opposite direction from which it was cocked. Observe pins of V-block on surface plate. If neither pin lifts from surface plate as piston is tipped, connecting rod is free of twist. If one of the pins lifts from the surface plate, connecting rod is twisted. Straighten twisted connecting rod with bending bar.

71. MISCELLANEOUS ENGINE REPAIRS.

a. General. Replace all gaskets.

b. Oil Pan. Bump dents from oil pan. Clean carbon from oil strainer screen with solvent and a wire brush. Clean up damaged threads with a thread tap. Replace oil pan if broken. In absence of a suitable replacement part, make temporary repairs by brazing.

c. Flywheel. Replace flywheel if cracked or broken. Replace dowel pins with oversized dowel if holes in flywheel are too large. Clean up threads in screw holes with a thread tap. Replace flywheel if threads are stripped or if ring gear teeth are broken or worn.

d. Crankshaft. If crankshaft gear is worn or broken, press it from crankshaft and press on new gear.

e. Main Bearings. Replace main bearings if scored, chipped, broken, burned, or worn. Replace shims if bent or torn. Replace caps if broken. Replace screws if broken or if threads are damaged.

Section XII

ENGINE ASSEMBLY AND INSTALLATION

72. ASSEMBLY.

a. **Install Idler Gear Onto Shaft** (fig. 130).

(1) Tap key to seat in keyway in shaft.

(2) Aline keyway in gear with key in shaft and press gear as far as it will go into shaft.

b. **Install Gear on Camshaft** (fig. 131).

(1) Tap key to seat in keyway at front end of shaft. Slide thrust washer onto shaft.

(2) Turn gear so timing mark (prick-punch mark) is on side of gear away from camshaft. Aline keyway in gear with key in shaft and press gear to seat on shaft.

(3) Install washer and nut on camshaft.

c. **Assemble Gear Cover** (fig. 132).

(1) Screw lock nut onto camshaft thrust screw. Start screw into its hole from outside of gear cover.

(2) Place plug in position with pinholes alined in idler gear thrust plate. Tap the two pins into pinholes.

(3) Position approximate number of shims (about 18) on plate and install plate on gear cover with the three lock washers and screws. Final shim adjustment will be made after gear cover installation.

(4) Press water pump drive shaft oil seal into its seat in gear cover. Be sure leather lip points toward inside of cover.

(5) Slide crankshaft oil seal into position in its seat on under side. Be sure leather lips point toward inside of cover.

d. **Assemble Connecting Rod and Piston Assembly** (fig. 133).

(1) Position rod within piston so that cap screw securing connecting rod to piston pin will be opposite the split on the piston skirt. Insert previously fitted piston pin through piston and rod. Turn pin to aline slot with screw hole in rod. Install piston pin screw and lock washer. Tighten screw securely.

(2) Using a piston ring expander, slide previously fitted oil ring over top of piston into lower ring groove of piston. In same manner, install three previously fitted compression rings in the upper grooves of piston.

e. **Assemble Oil Pump.** Refer to paragraph 47 e.

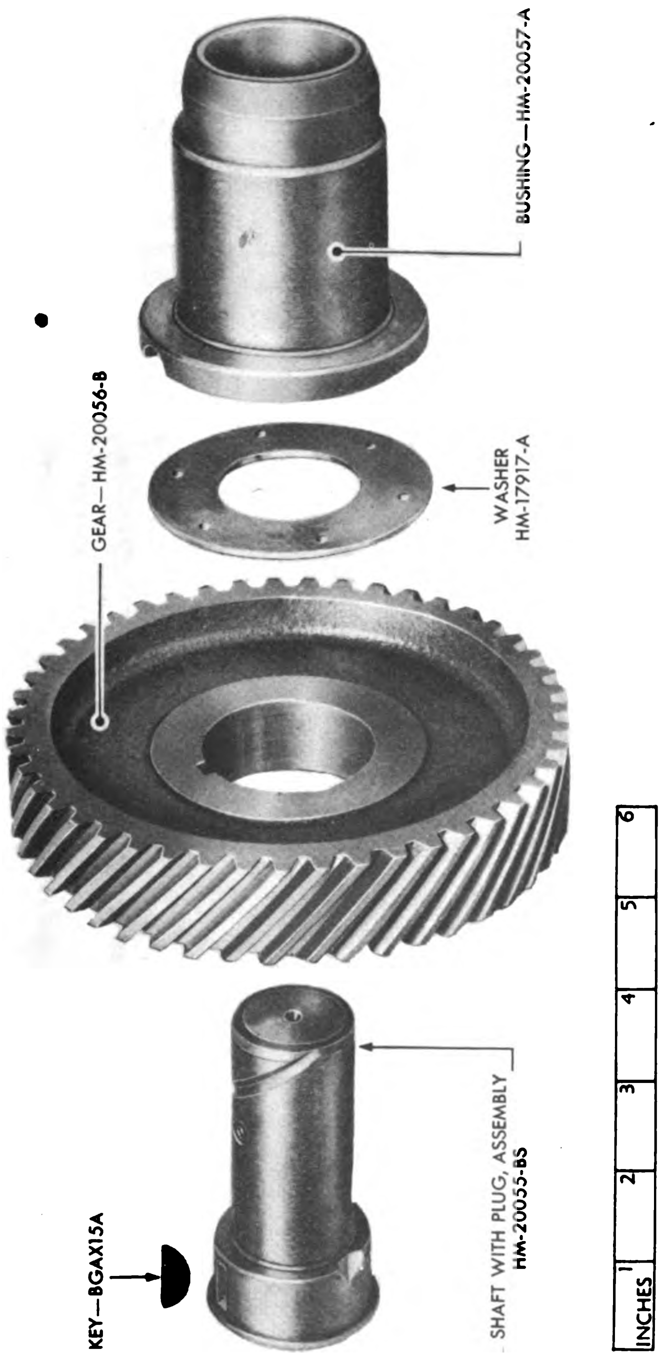

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Figure 130—Idler Shaft and Gear Disassembled

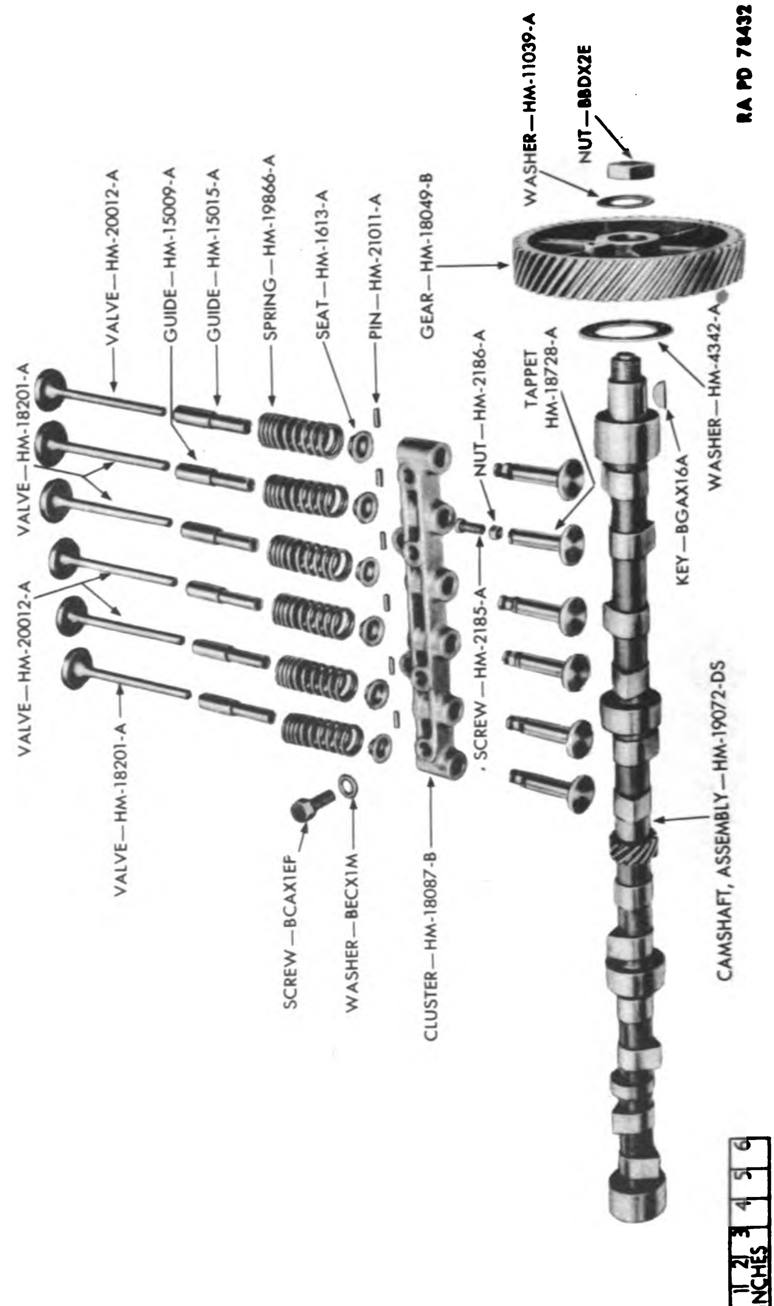

Figure 131—Valve Operating Mechanism Disassembled

ENGINE AND ACCESSORIES

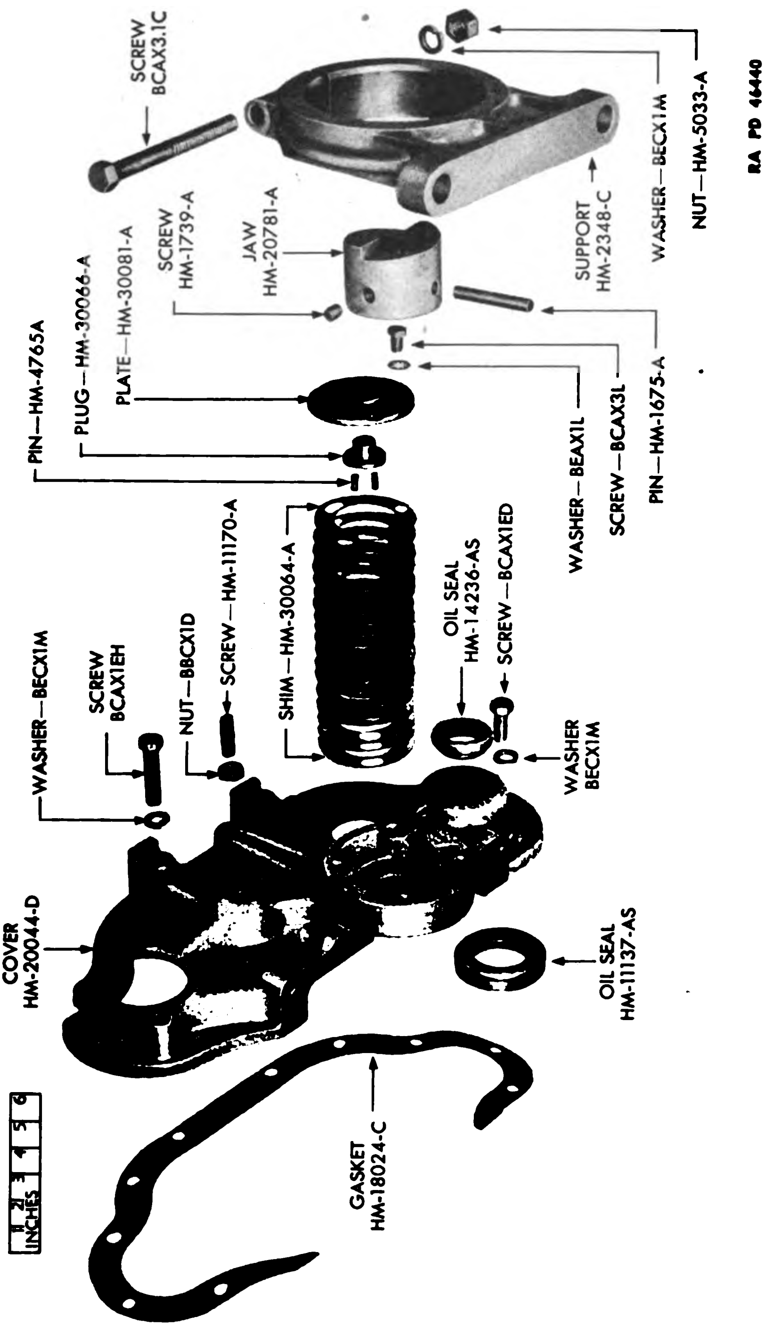

Figure 132—Gear Cover Disassembled

A—RING—HM-3818-A
B—RING—HM-3917-A
C—PISTON—HM-18709-C
D—PIN—HM-18876-B
E—WASHER—BEAX2A
F—SCREW—HM-11756-A
G—ROD—HM-21290-C
H—BOLT—HM-21055-A
J—SHIM—HM-35068-A
K—BEARING—HM-20198-B
L—WASHER—HM-19680-A
M—PIN—HM-1707-A
N—BEARING—HM-20074-B
P—BOLT—HM-7104-A
Q—SHIM—HM-35206-A
R—CAP—HM-20094-B
S—SCREW—HM-20097-A
T—BEARING—HM-20075-B
U—SHIM—HM-35208-A
V—CAP—HM-20095-B
W—SCREW—HM-20096-A
X—BEARING—HM-20073-B
Y—SHIM—HM-35207-A
Z—CAP—HM-20093-B
AA—NUT—BBFX1DA
BB—PIN—BFAX1DG
CC—CAP—HM-21291-C
DD—BEARING—HM-20072-B
EE—SHIM—HM-35205-A
FF—CAP—HM-20092-B
GG—CRANKSHAFT—HM-19136-E
HH—GEAR—HM-18039-B

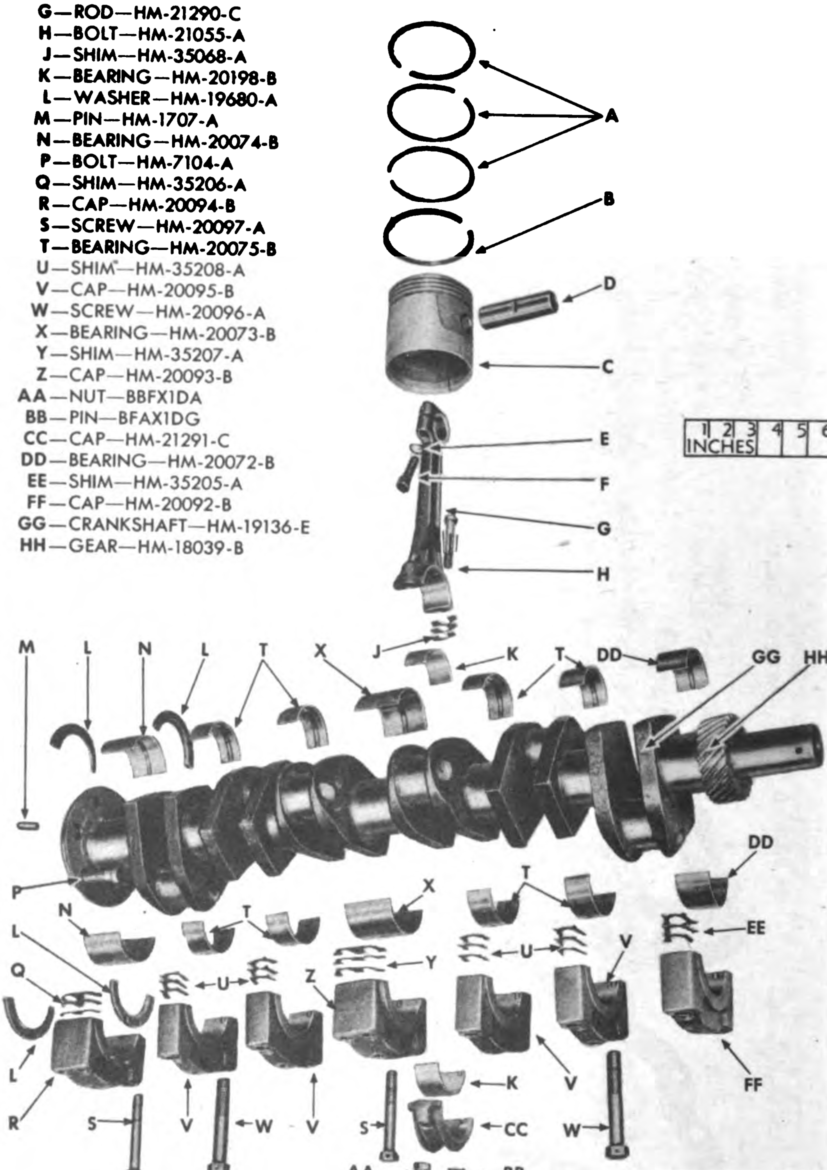

Figure 133—Piston, Connecting Rod, Crankshaft, and Bearing Arrangement

ENGINE AND ACCESSORIES

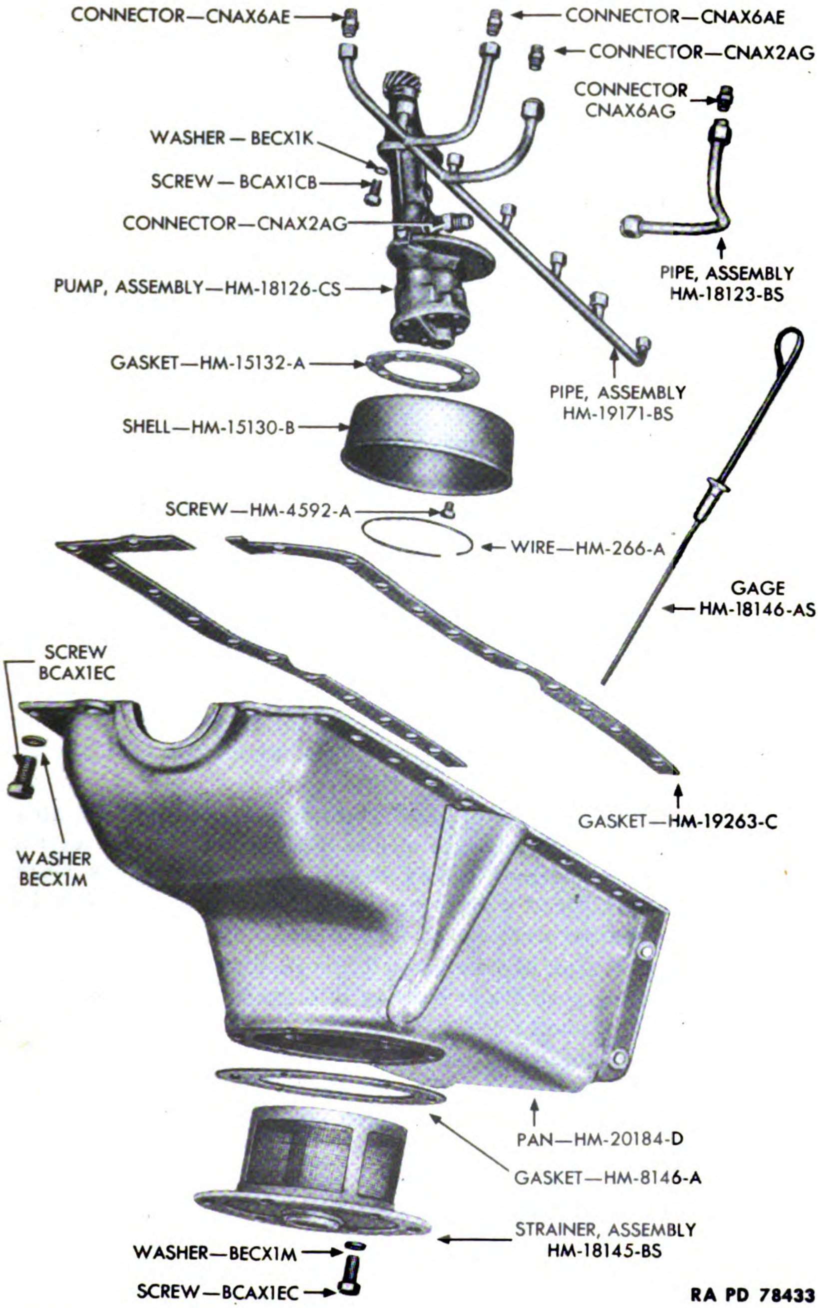

Figure 134—Oil Pan, Oil Pump, and Oil Pipe Arrangement

f. Assemble Oil Pan (fig. 134).

(1) Coat male threads of oil drain pipe elbow with white lead pigment and screw tightly into drain hole in oil pan strainer.

(2) Position strainer gasket and strainer on oil pan (elbow pointing to left). Install the six lock washers and cap screws which attach strainer to oil pan.

g. Assemble Valve Tappet Clusters (fig. 131).

(1) Screw lock nut onto each valve tappet adjusting screw. Screw each screw into top of a tappet.

(2) Insert tappets through tappet holes from under side of clusters.

h. Assemble Water Pump Drive (fig. 135).

(1) Tap key into position in keyway in drive shaft gear seat on front end of shaft. Aline keyway in gear with key on shaft. Press gear to seat on shaft. Press oil thrower, dished side out, onto front end of shaft until thrower seats against gear.

(2) Aline oilholes and slots in bushing and sleeve, and press bushing into sleeve. Press until ends of bushing and sleeve are flush. Slide sleeve, small end first, onto rear end of shaft.

(3) Tap distributor drive worm gear key to seat in keyway in shaft. Slide thrust washer onto rear end of shaft. Tap distributor drive gear, collar first, to seat on shaft over key and up against thrust washer.

(4) Install gear retaining nut. Tighten nut enough to eliminate noticeable end play of shaft in sleeve, but not enough to interfere with free rotation of shaft within sleeve. Slide special lock washer onto end of shaft. Bend washer over one of flats of nut. Install lock nut and bend washer over one of flats of lock nut.

(5) Press oil seal, leather lip pointing in, into its seat in housing. Slide new housing gasket and housing into position against flange on sleeve over end of shaft.

(6) Tap coupling sprocket key to seat in keyway on rear end of shaft. Press sprocket onto shaft over key. Drive taper pin through pinhole in sprocket and shaft, and peen pin to prevent it from working out.

i. Install Crankshaft (fig. 133).

(1) Place upper bearing shells in position in upper bearings, each shell in bearing from which removed if old bearings are reused. Coat bearing surface of each bearing with engine oil.

(2) Set crankshaft in position in upper bearings.

ENGINE AND ACCESSORIES

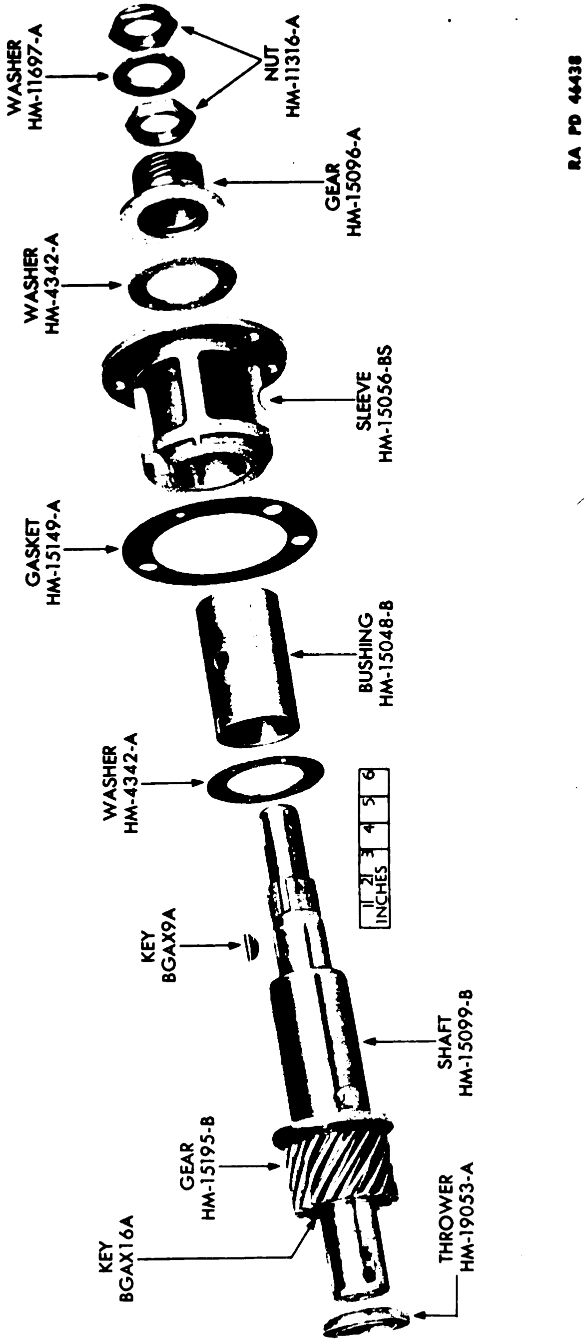

Figure 135—Water Pump Drive Disassembled

(3) Fit thrust washer halves into place between rear main bearing and crankshaft flange.

(4) Place rear main bearing shell and cap in position. Add or remove shims until crankshaft can be just turned with considerable effort. Then add a 0.002- to 0.003-inch shim to each side to obtain proper clearance. Tighten cap screw to 70 foot-pounds tension. Run No. 12 wire through holes of each pair of cap screw heads. Crimp wire together to lock screws.

(5) Repeat procedure of step (4), above, to install center main bearing shell and cap.

(6) Install front bearing cap (step (4), above). Proper wrench tension is 105 foot-pounds.

(7) Install rear intermediate bearing (step (4), above). Wrench tension is 105 foot-pounds.

(8) Install front intermediate bearing (step (4), above). Wrench tension is 105 foot-pounds.

j. **Install Bell Housing and Flywheel** (fig. 113).

(1) Position bell housing gasket and bell housing on rear end of cylinder block. Install the six lock washers and cap screws (two inside housing, four outside) which attach bell housing to block. Tighten screws securely.

(2) Place flywheel on rear end of crankshaft with dowels in dowel holes. Flywheel will fit in only one position and it goes on easily when properly positioned. Install the four castellated nuts which attach flywheel. Place a wood block between crankshaft and cylinder block to keep crankshaft from turning. Draw up on nuts evenly to insure proper seating of the flywheel against the crankshaft. Tighten nuts securely and install a new cotter pin through each nut.

k. **Install Camshaft and Time Engine (Valve Timing)** (fig. 136).

(1) Carefully insert camshaft in camshaft bearings in cylinder block. Do not allow cams to drag on or hit bearings.

(2) Turn crankshaft and camshaft so timing marks (prick-punch marks) are adjacent, and mesh gears.

l. **Install Idler Gear and Gear Cover** (fig. 119).

(1) Oil idler shaft with engine oil. Slide thrust washer onto idler shaft and slide idler shaft into bushing to left of camshaft gear. Mesh idler gear with camshaft gear.

(2) Spread a film of engine oil over gears exposed on front of engine.

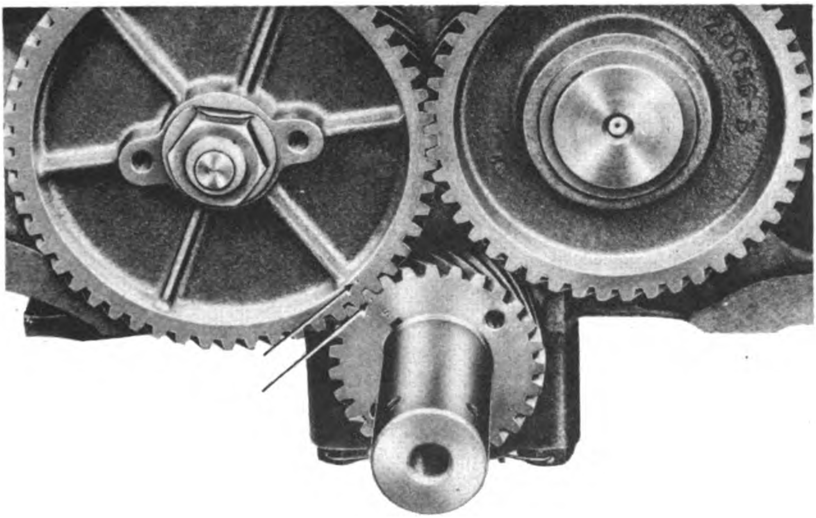

Figure 136—Crankshaft Gear and Camshaft Gear Timing Marks

(3) Check crankshaft oil seal to be sure it is installed in its seat on lower side of gear cover. Be sure internal and external leather lips point toward inside of cover.

(4) Position gear cover on front of cylinder block with oil seal around protruding end of crankshaft. Install the 10 lock washers and cap screws which attach cover to cylinder block. Place governor oil tube clip under head of top screw to left of center. Connect oil tube nut to fitting on left side of cylinder block adjacent to filter position.

(5) Tighten camshaft thrust screw until snug against end of camshaft. Back off screw one-quarter turn and tighten lock nut.

(6) Reaching through water pump drive hole, grasp idler gear. Test end play of idler shaft. It should be perceptible, but not excessive (0.003 to 0.010 inch). Add or remove shims from under thrust plug plate on outside of gear cover to secure proper adjustment.

m. **Install Cranking Jaw and Front Engine Support** (fig. 112).

(1) Aline pinholes in cranking jaw and front end of crankshaft. Drive jaw onto crankshaft. Drive pin into place through jaw and shaft. Install set screw which holds pin in position.

(2) Slide front engine support into place over collar on gear cover. Turn support so cap screw in support is horizontal and at top. Tighten cap screw securely. Tighten lock nut on cap screw.

(3) Fit thrust washer halves into place between rear main bearing and crankshaft flange.

(4) Place rear main bearing shell and cap in position. Add or remove shims until crankshaft can be just turned with considerable effort. Then add a 0.002- to 0.003-inch shim to each side to obtain proper clearance. Tighten cap screw to 70 foot-pounds tension. Run No. 12 wire through holes of each pair of cap screw heads. Crimp wire together to lock screws.

(5) Repeat procedure of step (4), above, to install center main bearing shell and cap.

(6) Install front bearing cap (step (4), above). Proper wrench tension is 105 foot-pounds.

(7) Install rear intermediate bearing (step (4), above). Wrench tension is 105 foot-pounds.

(8) Install front intermediate bearing (step (4), above). Wrench tension is 105 foot-pounds.

j. **Install Bell Housing and Flywheel** (fig. 113).

(1) Position bell housing gasket and bell housing on rear end of cylinder block. Install the six lock washers and cap screws (two inside housing, four outside) which attach bell housing to block. Tighten screws securely.

(2) Place flywheel on rear end of crankshaft with dowels in dowel holes. Flywheel will fit in only one position and it goes on easily when properly positioned. Install the four castellated nuts which attach flywheel. Place a wood block between crankshaft and cylinder block to keep crankshaft from turning. Draw up on nuts evenly to insure proper seating of the flywheel against the crankshaft. Tighten nuts securely and install a new cotter pin through each nut.

k. **Install Camshaft and Time Engine (Valve Timing)** (fig. 136).

(1) Carefully insert camshaft in camshaft bearings in cylinder block. Do not allow cams to drag on or hit bearings.

(2) Turn crankshaft and camshaft so timing marks (prick-punch marks) are adjacent, and mesh gears.

l. **Install Idler Gear and Gear Cover** (fig. 119).

(1) Oil idler shaft with engine oil. Slide thrust washer onto idler shaft and slide idler shaft into bushing to left of camshaft gear. Mesh idler gear with camshaft gear.

(2) Spread a film of engine oil over gears exposed on front of engine.

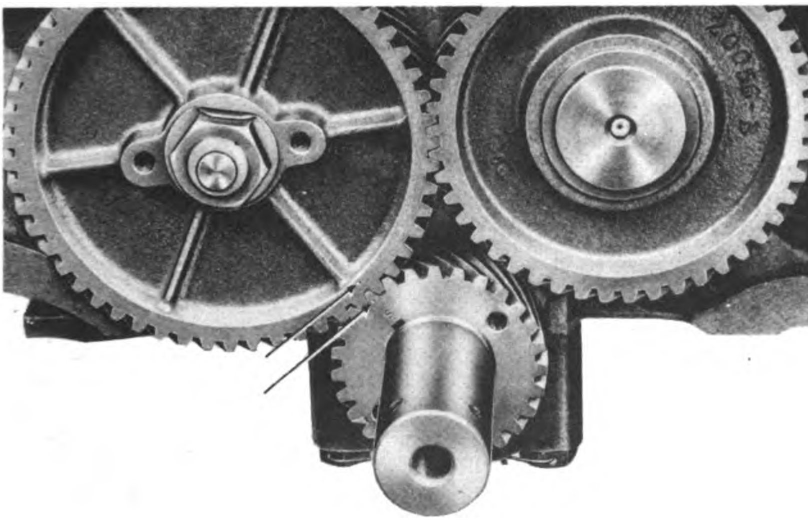

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Figure 136—Crankshaft Gear and Camshaft Gear Timing Marks

(3) Check crankshaft oil seal to be sure it is installed in its seat on lower side of gear cover. Be sure internal and external leather lips point toward inside of cover.

(4) Position gear cover on front of cylinder block with oil seal around protruding end of crankshaft. Install the 10 lock washers and cap screws which attach cover to cylinder block. Place governor oil tube clip under head of top screw to left of center. Connect oil tube nut to fitting on left side of cylinder block adjacent to filter position.

(5) Tighten camshaft thrust screw until snug against end of camshaft. Back off screw one-quarter turn and tighten lock nut.

(6) Reaching through water pump drive hole, grasp idler gear. Test end play of idler shaft. It should be perceptible, but not excessive (0.003 to 0.010 inch). Add or remove shims from under thrust plug plate on outside of gear cover to secure proper adjustment.

m. **Install Cranking Jaw and Front Engine Support** (fig. 112).

(1) Aline pinholes in cranking jaw and front end of crankshaft. Drive jaw onto crankshaft. Drive pin into place through jaw and shaft. Install set screw which holds pin in position.

(2) Slide front engine support into place over collar on gear cover. Turn support so cap screw in support is horizontal and at top. Tighten cap screw securely. Tighten lock nut on cap screw.

n. Install Connecting Rods (fig. 133).

(1) Coat pistons and bearing surfaces with seasonal grade engine oil.

(2) Compress rings on No. 1 piston with a piston ring compressor.

(3) Turn piston so that the side marked "FRONT" is toward front of engine. Insert assembly, connecting rod first, into No. 1 cylinder. Tap top of piston with a wood block. Remove piston ring compressor from piston after rings enter cylinder.

(4) Fit upper connecting rod bearing shell in place in connecting rod. Fit connecting rod over crankshaft. Insert connecting rod cap bolts through holes in base of rod from top. Place connecting rod bearing shell and cap in position on screws. Install shims calculated to carry proper clearance around cap bolt on side opposite camshaft. Tighten connecting rod castellated nuts to 63 foot-pounds pressure. Crank engine. Add or remove shims until engine can be just turned over with considerable force. Then add a 0.0015- to 0.002-inch shim to obtain required clearance. Tighten nuts to 63 foot-pounds pressure and install cotter pins.

(5) Similarly install the five remaining pistons.

o. Install Oil Pipe, Oil Pump, and Oil Pan (fig. 134).

(1) Place oil pipe in position with pipe ends against engine fittings. Tighten oil pipe sleeve nuts to fittings.

(2) Place oil pump in position on cylinder block. Tightly install the four lock washers and cap screws which attach pump to cylinder block. Screw oil pipe sleeve nut onto fitting on pump.

(3) Coat the two halves of the cylinder block to oil pan gasket with gasket cement and stick them in position on the machined surfaces on the lower edge of the cylinder block. Push oil pan against gasket and against bell housing gasket. Install the 29 lock washers and cap screws which attach oil pan to cylinder block and bell housing.

p. Install Valve Tappet Clusters and Valves (fig. 131).

(1) Place tappet cluster with tappets in position in valve chamber on right side of cylinder block. Install the four lock washers and screws which attach cluster to block. Similarly install other cluster in other valve chamber.

(2) Insert valve spring seats in loosely coiled end of valve springs and place spring and seats in position between top of valve chamber and tappets. Insert each valve stem into valve guide in which it was originally installed. Insert valve spring lifter between top of tappet cluster and spring seat. Compress spring and lock lifter in place. Insert pin in slot in valve stem. Release lifter tension on spring and remove lifter. Similarly install remaining valve spring seat pins.

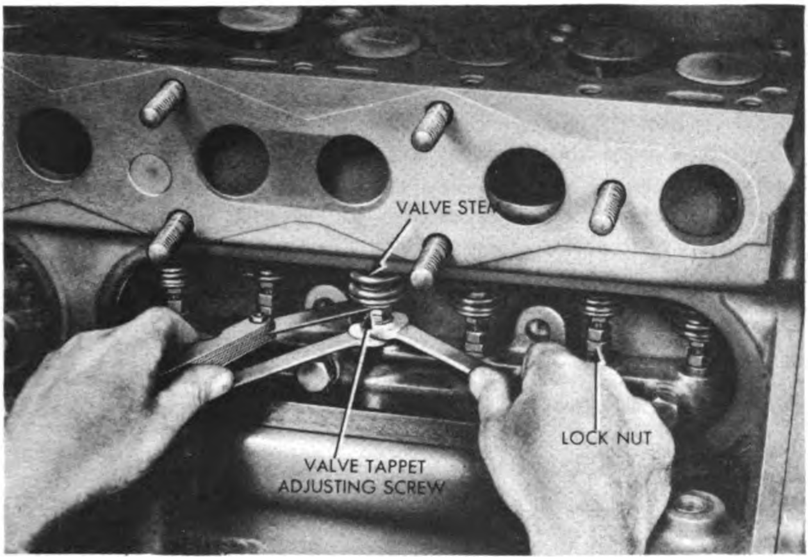


Figure 137—Valve Adjustment

q. **Adjust Valve Tappets** (fig. 137). From front to rear of engine, exhaust valves are Nos. 1, 4, 5, 8, 9, and 12; intake valves are Nos. 2, 3, 6, 7, 10, and 11. To adjust valves on No. 1 cylinder, turn engine over with hand crank until intake valve of No. 6 cylinder begins to open. Loosen lock nut on valve tappet adjusting screw. Adjust screw so clearance between screwhead and valve stem is 0.010 for intake valve and 0.016 for exhaust valve (cold engine). Crank engine until No. 2 cylinder intake valve opens, and adjust valves in No. 5 cylinder. If No. 4 intake valve opens, adjust valves in No. 3 cylinder. When No. 1 intake valve opens, adjust valves in No. 6 cylinder. When No. 5 cylinder intake valve opens, adjust valves in No. 2 cylinder. When No. 3 intake cylinder opens, adjust valves in No. 4 cylinder. Valves will be reset to 0.006 intake, 0.010 exhaust (hot engine) after engine is installed and warmed up.

r. **Install Cylinder Head** (fig. 112).

(1) Place a new cylinder head gasket in position on cylinder block. Set cylinder head in position on gasket. Install cylinder head cap screw fingertight with spark plug wire tube in position under two of the screws.

(2) Tighten screw in rotation, a part turn at a time, beginning at the center of the head and working to the outside. Use a tension wrench and tighten to 60 foot-pounds when using copper asbestos gasket, or 75 foot-pounds when using steel asbestos gasket.

s. Install Water Pump Drive and Shaft Pulley (fig. 112).

(1) Using new gasket, push water pump drive housing to flange on left side of engine. Rotate shaft as necessary to mesh gears.

(2) Install the three lock washers and cap screws which attach water pump drive housing to cylinder block.

(3) Tap water pump pulley key to seat in front end of water pump drive shaft. Aline keyway in pulley with key on shaft and press pulley onto shaft. Drive drift pin through pinhole in pulley and shaft. Install new cotter pin at each end of drive pin to hold it in position.

t. Install Oil Filler Pipe Adapter. Place adapter (fig. 112) in position on its boss on left side of cylinder block. Using a soft block, tap adapter to seat.

73. INSTALLATION OF ACCESSORIES.

a. Install distributor (par. 54 f).

b. Position oil filler pipe and breather assembly in oil pipe adapter. Tap pipe to seat within the adapter.

c. Using a new gasket, push governor in place on right front of cylinder block. Install the two lock washers and cap screws which hold governor to engine. Connect oil line to elbow on top of governor (fig. 13).

d. Install the following assemblies according to instructions in TM 9-617: both starting motors, ignition coil, spark plugs, battery charging generator, fuel pump, manifold, throttle body, carburetor, water pump, bypass, thermostat with housing, bayonet-type oil gage, fan and bracket, and fan belt.

74. INSTALLATION.

a. General. There are two alternatives for engine installation, depending upon alternative chosen for removal. The engine and generator assembly can be installed as a unit or engine can be installed by itself. Each method is given below.

b. Engine Installation.

(1) Hoist engine into position on frame (fig. 109).

(2) Attach engine to a-c generator (par. 86).

(3) Install the two bolts, lock washers, and nuts which attach front engine support (fig. 112) to frame and remove hoist from engine.

(4) Connect oil pressure gage line to fitting on base of oil filter (fig. 12).

(5) Insert temperature gage bulb into fitting on left rear corner of cylinder head and tighten bulb nut onto fitting (fig. 12).

(6) Screw oil drain pipe into elbow on under side of oil pan (fig. 116) and install drain plug. Use white lead pigment on threads of pipe and tighten pipe securely.

(7) Connect cable to terminal on each starting motor (figs. 12 and 13).

(8) Install muffler and exhaust tube.

(9) Connect terminal block to ignition coil wire to "IGN" terminal of ignition coil (fig. 12).

(10) Connect "CG" wire to "CG" terminal of two-charge regulator (fig. 13).

(11) Connect tank-to-valve gasoline line to valve at fuel pump (fig. 13).

(12) Position gasket between air intake elbow and carburetor and install lock washers and cap screws which attach elbow to carburetor. Connect choke control to air shutter lever on carburetor. Be sure to have control pushed in and air shutter open when connection is made. Connect throttle control to throttle lever on carburetor. Be sure to have throttle control pushed in and throttle valve open when connection is made (fig. 12).

(13) Install radiator base support, radiator (par. 28 f), hood, all four side panels, and all four doors.

(14) Fill crankcase with engine oil to "4/4" mark on bayonet gage.

(15) Fill cooling system with clean fresh water or antifreeze solution. Do not use salt water in cooling system.

c. Installation of Engine and Generator Assembly.

(1) Connect engine to generator (par. 86).

(2) Hoist engine and generator assembly into position on frame (fig. 106).

(3) Install the six bolts, lock washers, and nuts which attach engine and generator assembly to frame. Remove hoist from assembly.

(4) Position rear fan cover on generator and install the lock washers and screws which attach cover to generator housing.

(5) Install muffler and exhaust tube.

(6) Apply white lead pigment to threads on oil drain pipe and tighten pipe securely into elbow on bottom of oil pan (fig. 116). Tighten drain plug into pipe.

(7) Install radiator (par. 28 f), center upright frame, rear upright frame, battery and tool box shelf, instrument panel (par. 96), hood, all four side panels, and all four doors.

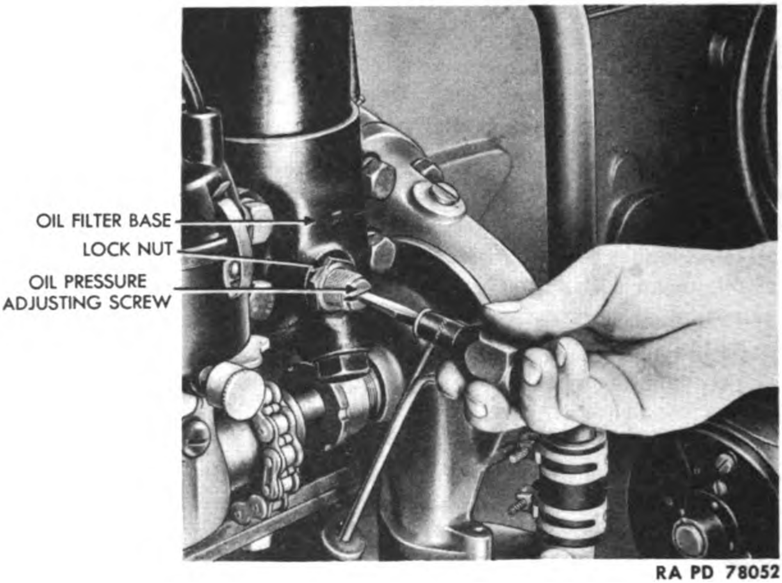


Figure 138—Oil Pressure Adjustment

(8) Fill crankcase with seasonal grade engine oil to "4/4" mark on gage.

(9) Fill cooling system with clean fresh water or antifreeze solution. Do not use salt water.

75. TESTS AND ADJUSTMENTS.

a. Before Starting Engine.

(1) Check oil, coolant, and gasoline supplies. Make up any deficiencies.

(2) Open valve at each end of tank to pump gasoline line.

(3) Check cooling system for leaks. Repair all leaks.

(4) Check fuel system for gasoline leaks. Repair all leaks.

(5) Check engine for oil leaks. Repair all leaks.

(6) Examine ignition wires, battery charging generator circuit wires, and a-c generating system wires to be sure all connections are made and tight.

(7) Lubricate engine accessories.

(8) Hand-crank engine through a few revolutions. This will determine whether the engine is free, without causing damage. Repair any malfunction which this precaution might reveal.

b. After Starting Engine.

(1) After starting engine and allowing it to run a few seconds, note reading of oil pressure gage. Turn engine off immediately if no oil pressure is indicated. Locate and correct the cause before starting engine.

(2) Listen for knocks or noises indicating malfunctioning of engine or accessories. Locate and correct the cause of any such noises.

(3) Inspect cooling system, engine, and fuel system to see if leakage of coolant, engine oil, or gasoline is in evidence. Repair all leaks.

(4) Inspect manifold exhaust tube and muffler for leakage of exhaust gases. Repair leaks.

(5) Add seasonal grade engine oil to "4/4" mark on gage to compensate for oil contained in oil filter, governor, and oil pipes.

(6) After engine has run for at least 15 minutes and is thoroughly warmed up, adjust oil pressure to 25-pound pressure at 1,200 revolutions per minute. This is done by turning the adjusting screw in the oil filter base (fig. 138). Tightening screw increases pressure.

(7) Adjust valve tappets. Proper clearance is 0.006 inch for intake and 0.010 inch for exhaust valves with engine thoroughly warmed up. Detailed procedure for valve adjustment is given in paragraph 72 q.

(8) After engine has had from 5 to 10 hours service, check tightness of mounting bolts, cylinder head screws, hose clamp screws, accessory mounting screws, and electrical connections.

Section XIII

CONSOLIDATED ENGINE SERVICE DATA

76. FITS AND CLEARANCES.

a. Clearances.

Main bearings	0.002 to 0.003 in.
Connecting rod bearings	0.0015 to 0.002 in.
Camshaft bearings	0.0015 to 0.0025 in.
Idler bearing clearance	0.001 to 0.0025 in.
Water pump drive shaft bearings	0.0015 to 0.0025 in.
Valve tappets (engine hot):	
Intake	0.006 in.
Exhaust	0.010 in.
Piston to cylinder wall	0.003 to 0.0035 in.
Piston pin to piston	0.0002 to 0.0003 in.
Piston rings:	
End gap	0.015 to 0.020 in.
Ring to piston (in groove)	0.001 to 0.0025 in.
Bell housing on chamber	0.012 to 0.025 in.

Gear cover clearance around water pump drive shaft	0.006 to 0.015 in.
Oil pan clearance around crankshaft	0.008 to 0.015 in.
Carburetor:	
Metering well to bowl	(max) 0.005 in.
Float bottom to cover bottom	$1\frac{7}{32}$ to $1\frac{9}{32}$ in.

b. Gap Settings.

Distributor points	0.020 in.
Spark plugs	0.025 in.
Two-charge regulator:	
Circuit breaker armature	0.010 to 0.030 in.
Circuit breaker contact	0.015 to 0.045 in.
Voltage regulator armature	0.044 to 0.046 in.
Voltage regulator contact	0.005 in. min

c. Gear Backlash.

Water pump drive gear to idler	0.002 to 0.004 in.
Idler gear to cam gear	0.001 to 0.002 in.
Cam gear to crankshaft gear	0.000 to 0.001 in.
Oil pump gear to cam gear	0.008 to 0.010 in.

d. End Thrust.

Crankshaft	0.003 to 0.005 in.
Water pump drive shaft	0.001 to 0.003 in.

77. WRENCH TENSIONS.

	Foot-pounds
Main bearing cap screws, rear and center	70
Main bearing cap screws, front and intermediate	105
Connecting rod bearing cap bolt nuts	63
Cylinder head cap screws:	
Copper asbestos gasket	60
Steel asbestos gasket	75

78. MISCELLANEOUS DATA.

Distributor breaker arm spring tension	12 to 17 oz
Firing order	1-5-3-6-2-4
Valve seats:	
Angle	45 deg
Width	$\frac{1}{8}$ to $\frac{5}{32}$ in.
Diameter, intake	$1\frac{13}{16}$ in.
Diameter, exhaust	$1\frac{11}{16}$ in.
Valve timings:	
Intake opens	1 deg 52 min past dead center
Intake closes	46 deg 52½ min past bottom center
Exhaust opens	43 deg 7½ min before bottom center
Exhaust closes	1 deg 52½ min past dead center

CHAPTER 5

A-C GENERATING SYSTEM

Section I

A-C GENERATOR

79. DESCRIPTION (figs. 139 and 140).

a. The a-c generator consists of two generators mounted on the same shaft in the same housing. The smaller of the two generators, the exciter, is a direct-current stationary field type. Its function is to furnish direct-current excitation for the revolving field coils of the other generator. The other generator, the alternator, is an alternating-current revolving field type generator. Its function is to deliver the electrical output of the unit. The exciter is located to the rear of the alternator. A brush holder assembly is located to the rear of the exciter just in front of the single generator bearing. This holder serves both the exciter commutator brushes and the alternator slip ring brushes. Brush holders are radial box type. They are readily accessible by removing guards and covers from rear of generator. Fans, to cool the assembly during operation, are keyed to the front and rear ends of the shaft. Both fans are outside the generator housing proper. The rear fan is covered by a guard. The front fan is within the engine bell housing and is attached by cap screws. It serves as a part of the flexible coupling between the rotor and engine.

b. The exciter armature coils are mounted on a sleeve which is keyed to and pressed onto the rotor shaft. The armature is removable as an assembly. The exciter field coils are attached to the rear bracket by pole pieces and screws. They can be replaced individually.

c. The revolving field coils of the alternator are pressed onto and keyed to the rotor shaft. They are not designed to be removed as a service operation. The alternator stator is pressed into and pinned to the housing at the factory. This is a factory operation and it is not intended that either the stator or housing be serviced separately.

d. At 1,200 revolutions per minute, this 3-phase, 60-cycle, 30-kilowatt, 80 percent power factor generator delivers a maximum 165 amperes at 125 volts, or 85 amperes at 250 volts. Voltage delivered depends on the setting of the generator terminal box on the upper left side of the generator housing.

80. SPECIFICATIONS.

Model	M3
Speed	1,200 rpm
Voltage	125 or 250

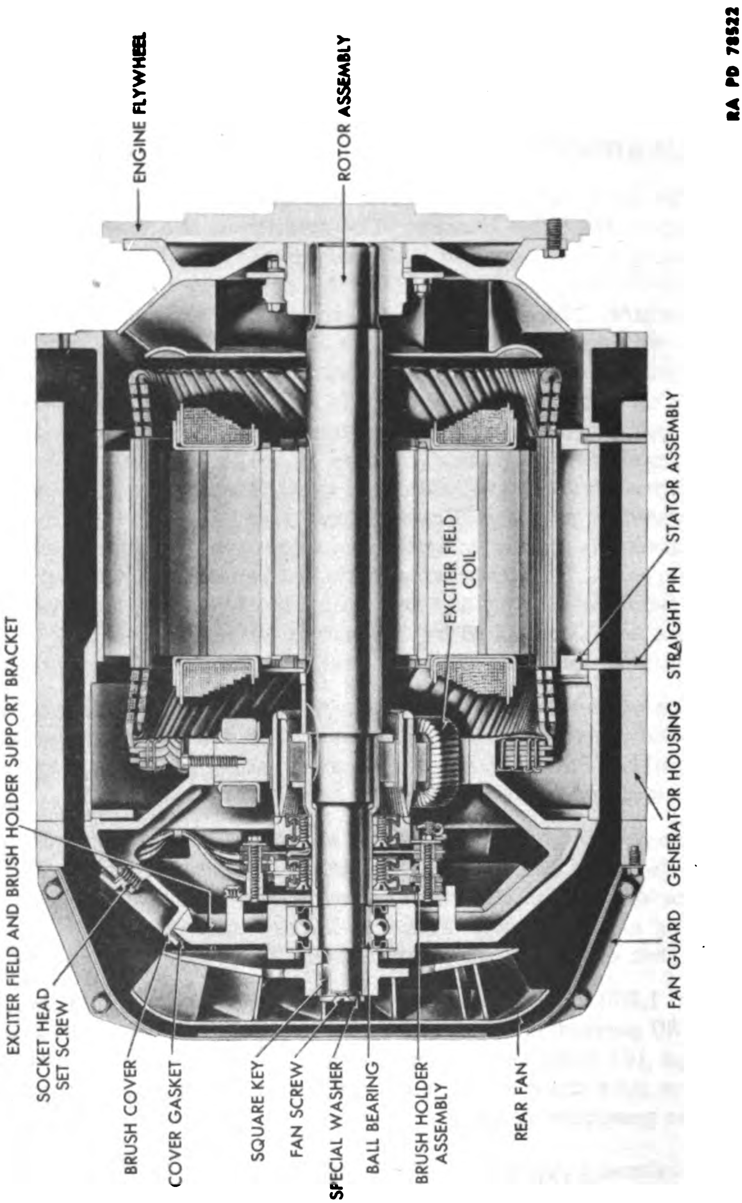


Figure 139—A-C Generator—Cross Section View

A-C GENERATING SYSTEM

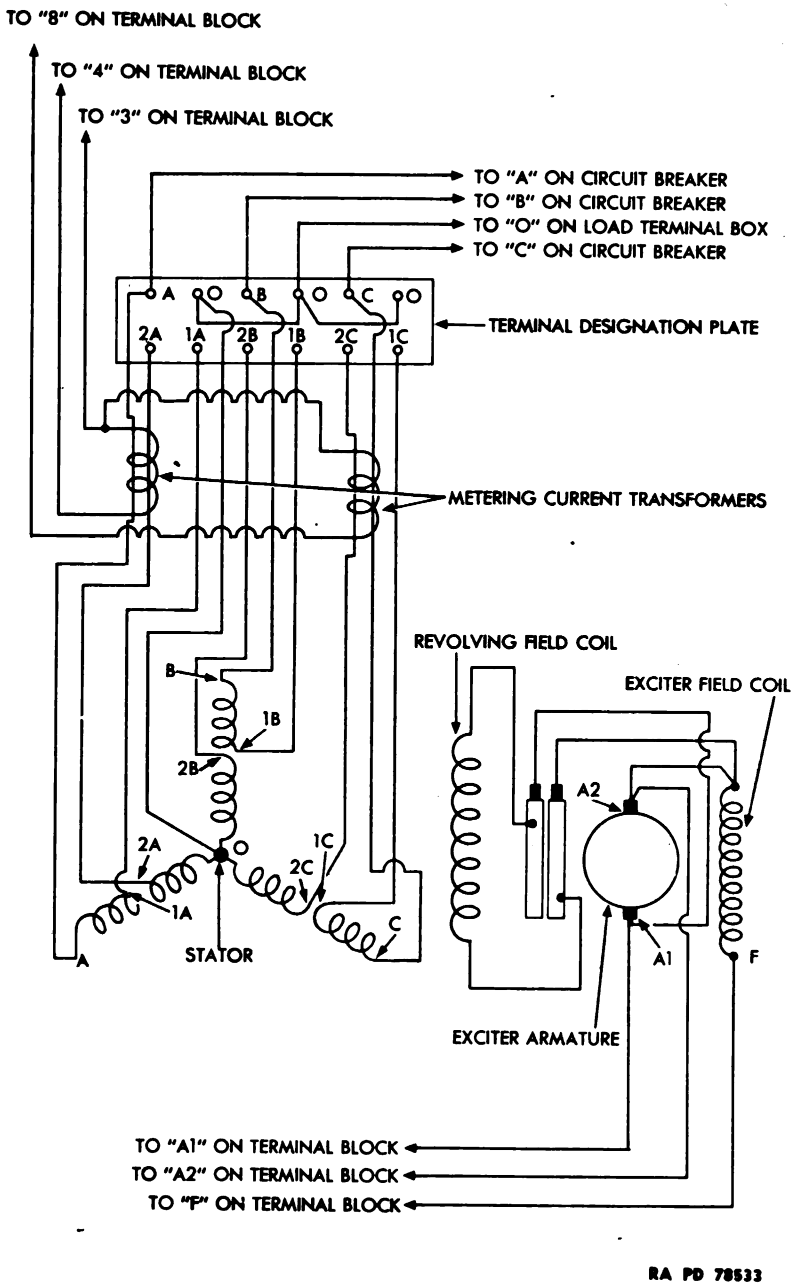
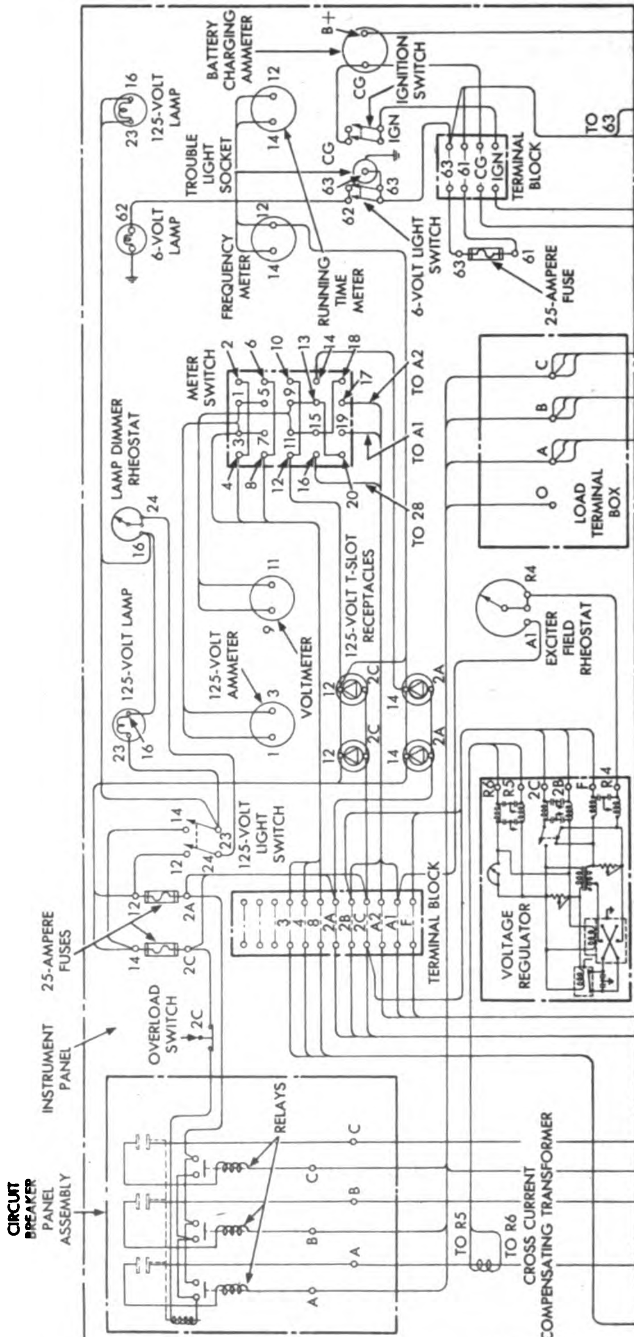
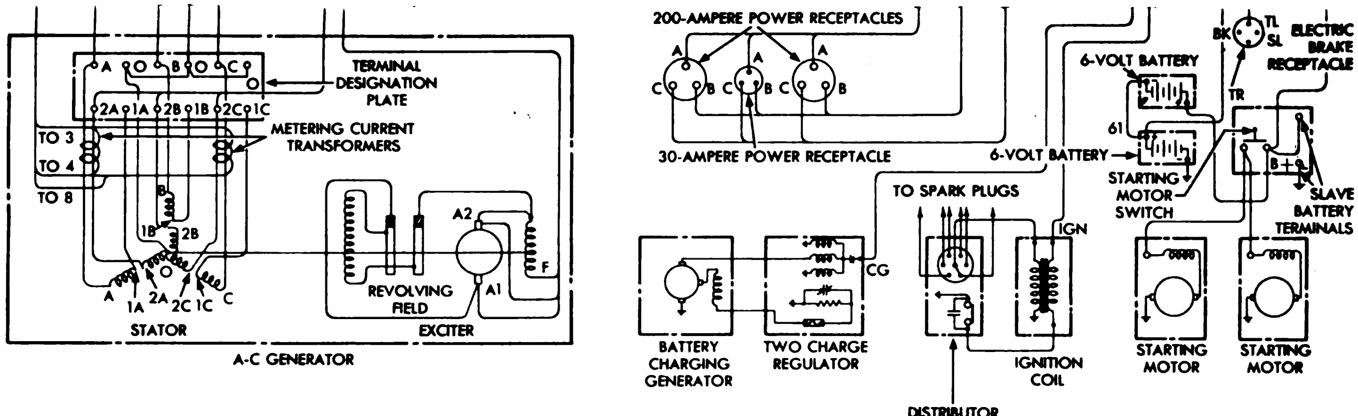


Figure 140—A-C Generator Wiring Diagram


BATTERY CHARGING AMMETER
IGNITION SWITCH
125-VOLT LAMP
TROUBLE LIGHT SOCKET
6-VOLT LAMP
FREQUENCY METER
RUNNING TIME METER
6-VOLT LIGHT SWITCH
TERMINAL BLOCK
25-AMPERE FUSE
TO 63
LAMP DIMMER RHEOSTAT
METER SWITCH
TO A2
TO A1
TO 28
LOAD TERMINAL BOX
125-VOLT LAMP
125-VOLT AMMETER
VOLTMETER
125-VOLT T-SLOT RECEPTACLES
EXCITER FIELD RHEOSTAT
125-VOLT LIGHT SWITCH
TERMINAL BLOCK
VOLTAGE REGULATOR
25-AMPERE FUSES
INSTRUMENT PANEL
OVERLOAD SWITCH
RELAYS
CIRCUIT BREAKER PANEL ASSEMBLY
TO R5
TO R6
CROSS CURRENT COMPENSATING TRANSFORMER



METER SWITCH CONNECTIONS			
POSITION A	POSITION B	POSITION C	POSITION EXC
1 TO 2	1 TO 2	3 TO 4	3 TO 4
7 TO 8	5 TO 6	5 TO 6	7 TO 8
9 TO 10	13 TO 14	11 TO 12	17 TO 18
15 TO 16	15 TO 16	13 TO 14	19 TO 20

SMALL WIRE COLOR CODE

LINE A—RED TRACE
LINE B—GREEN TRACE
LINE C—BLUE TRACE
12-VOLT—BLACK FIELD
EXCITER A1—BLACK TRACE
EXCITER A2—WHITE FIELD

RA PD 78600

Figure 141—Wiring Diagram of Generating Unit M18

Amperage (max):

At 125 volts	162 to 165 amp
At 250 volts	81 to 85 amp
Phase	3
Cycle	60
Power factor	0.8
KVA	35
KW	28

Direct-current excitation:

Amperes	10.8
Volts	62.5

Temperature rise:

Armature	65°C
Field	65°C
Time rating	25 percent overload, 2 hr
Rotation (viewed from front end)	Clockwise

81. REMOVAL.

a. Remove all four doors, hood, both rear side panels, gasoline tank (par. 37 a), instrument panel (par. 92), battery and tool box shelf, and rear upright frame.

b. Place blocks between engine bell housing and frame to support rear end of engine when generator is disconnected.

c. Remove the eight cap screws and lock washers which attach each of the two engine bell housing cover plates to bell housing. Lift plates and gasket from engine.

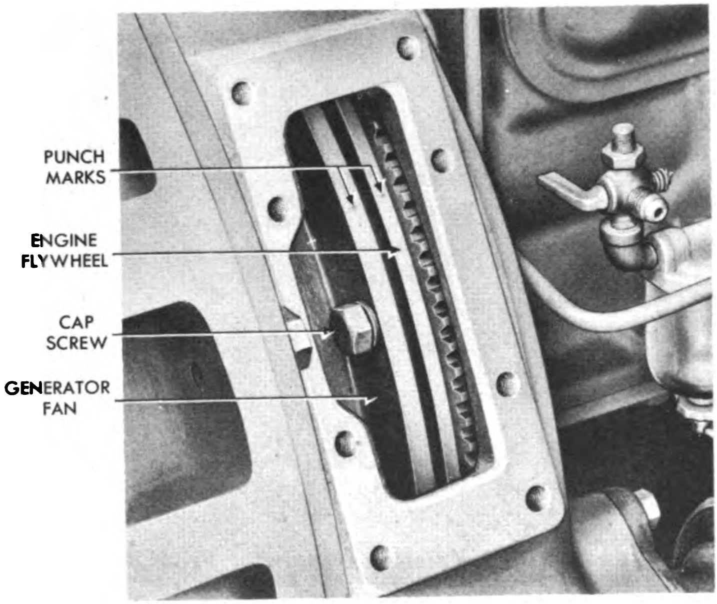
d. On adjacent points of generator fan and engine flywheel, prick-punch marks to make possible assembly in same position.

e. Remove the eight cap screws and lock washers which attach generator fan to engine flywheel (fig. 142).

f. Remove cap screws and lock washers which attach fan guard to rear of generator. Lift guard from generator.

g. Connect a hoist to a chain sling attached to exciter field and brush holder support bracket, and front end of starter housing. Remove top center bell housing to generator cap screw and install screw on inside of housing vent hole to attach chain (fig. 143). Support weight of generator with hoist.

h. Remove the 12 screws and lock washers which attach engine bell housing to generator housing.



RA PD 78514

Figure 142—Generator Fan to Engine Flywheel Attachment

i. Remove the four nuts, lock washers, cap screws, and special washers which secure generator to frame.

j. Swing generator back to clear engine (fig. 143) and lift from unit.

82. DISASSEMBLY.

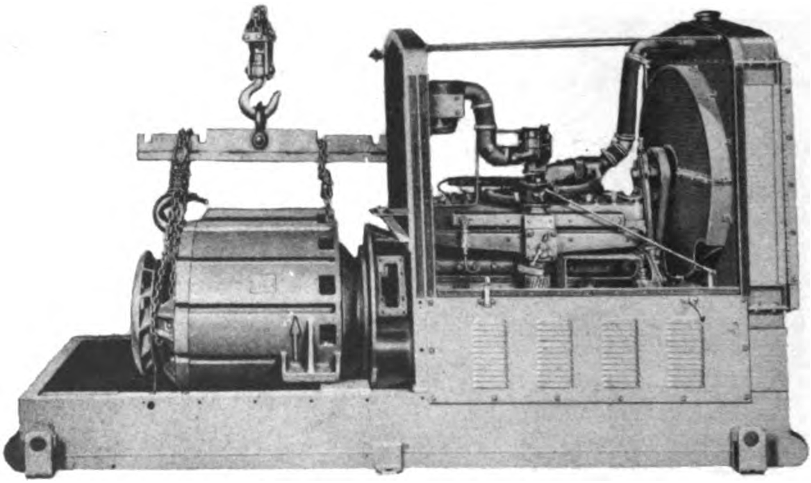
a. **Remove Rear Fan and Exciter Field and Brush Holder Support Bracket.**

(1) Remove fan screw and special washer which attaches rear fan to rotor shaft. Pull fan from shaft. Tap key from shaft (fig. 144).

(2) Lift all brushes in holders so arm and spring hold them clear of rotor.

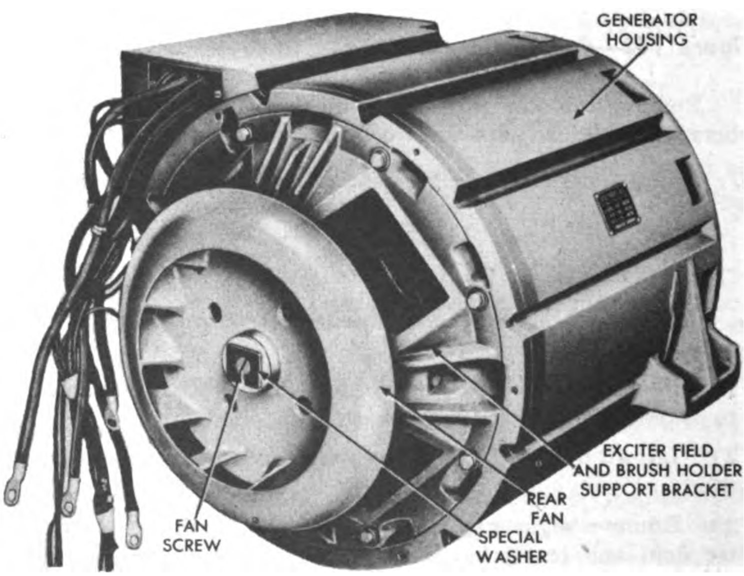
(3) Remove eight cap screws and lock washers which attach exciter field and brush holder support bracket to rear of housing (fig. 144). Lift bracket from generator (fig. 145).

b. **Remove Front Fan** (fig. 146). Remove the four special nuts, washers, and bolts which attach laminated coupling disks to shaft spider. During removal of nuts, hold bolts with a ⅝-inch open-end



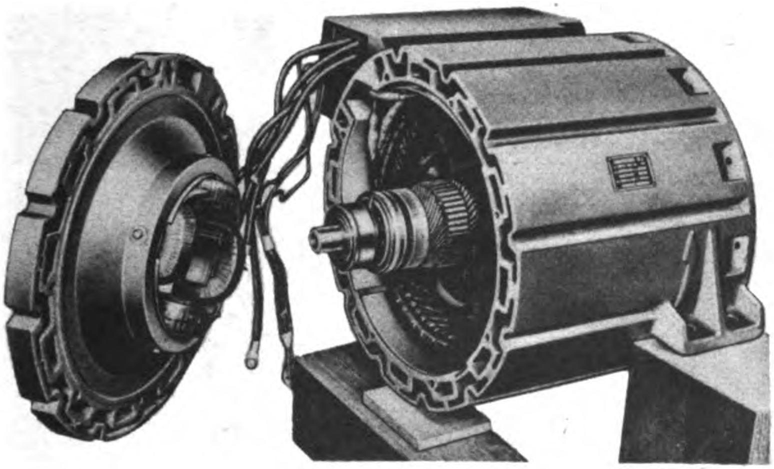
RA PD 78604

Figure 143—Hoisting Generator From Unit



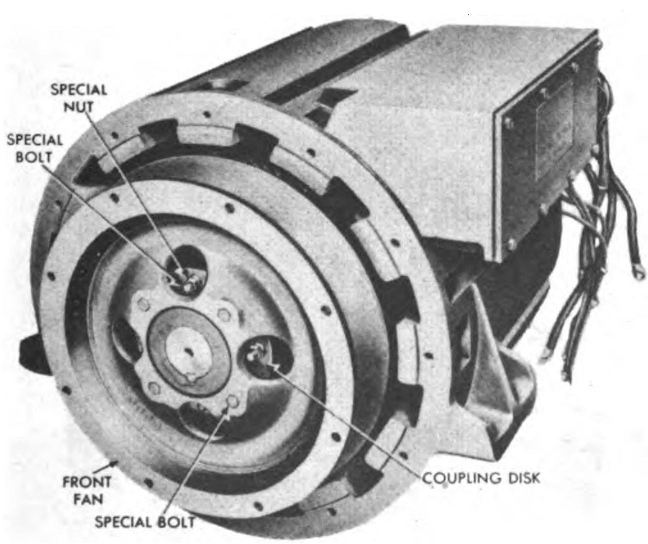
RA PD 78552

Figure 144—A-C Generator—Fan Guard and Brush Covers Removed



RA PD 78558

Figure 145—Exciter Field and Brush Holder Support Bracket Removal



RA PD 78573

Figure 146—A-C Generator Front Fan Attachment

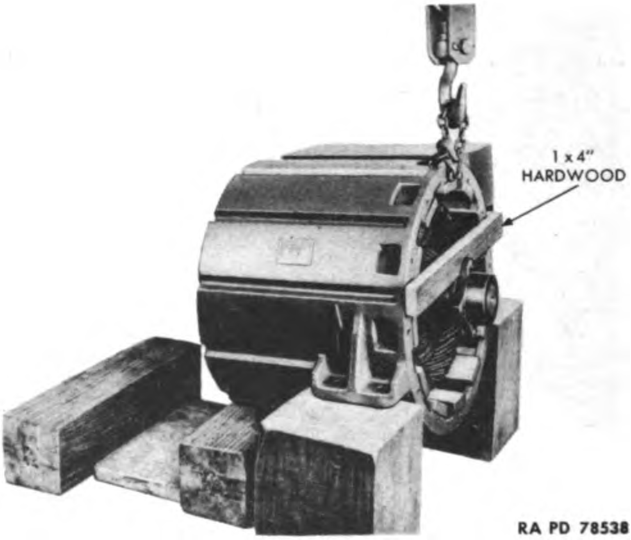


Figure 147—Positioning Generator for Rotor Removal (1)

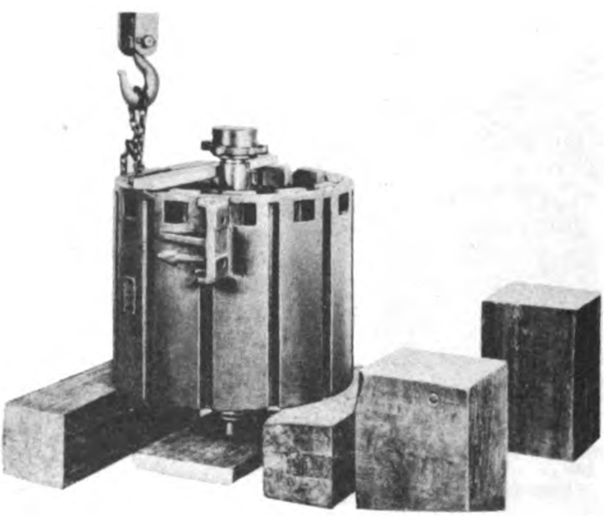
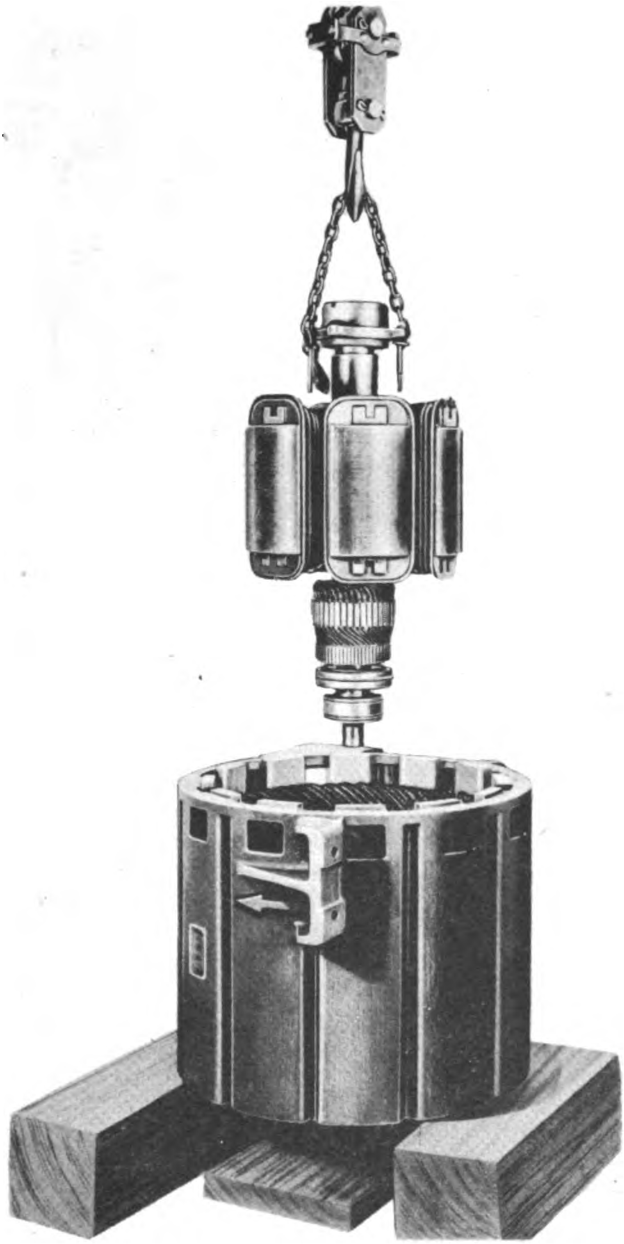
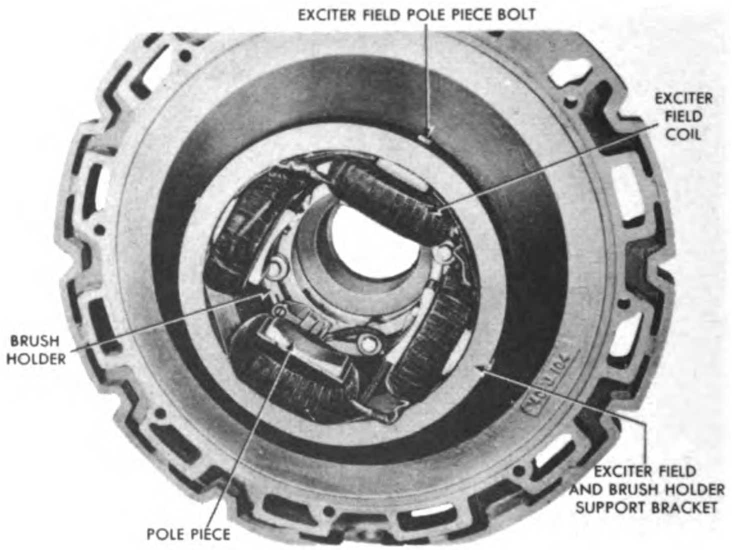


Figure 148—Positioning Generator for Rotor Removal (2)



RA PD 78530

Figure 149—A-C Generator Rotor Removal



RA PD 78559

Figure 150—Exciter Field and Brush Holder Support Bracket—Coils and Holder Installed

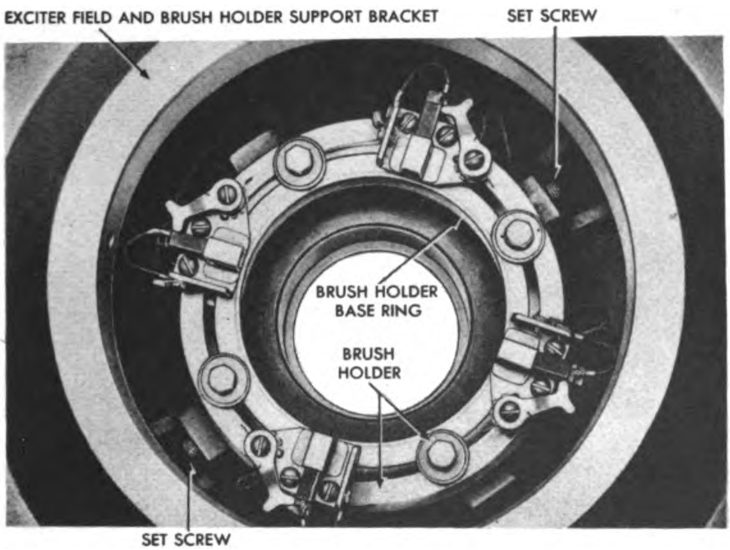
wrench inserted behind fan. Lift fan with attached coupling from front end of generator.

c. Remove Rotor.

(1) Place a timber of same size used to block up back of generator about 2 feet behind block under rear of generator. Lay a board on floor between blocks positioned so as to protect end of rotor shaft when generator is tipped back onto rear blocks. Place a 1-inch hardwood board across front end of housing under rotor spider. This board is to keep rotor from sliding back when generator is tipped (fig. 147).

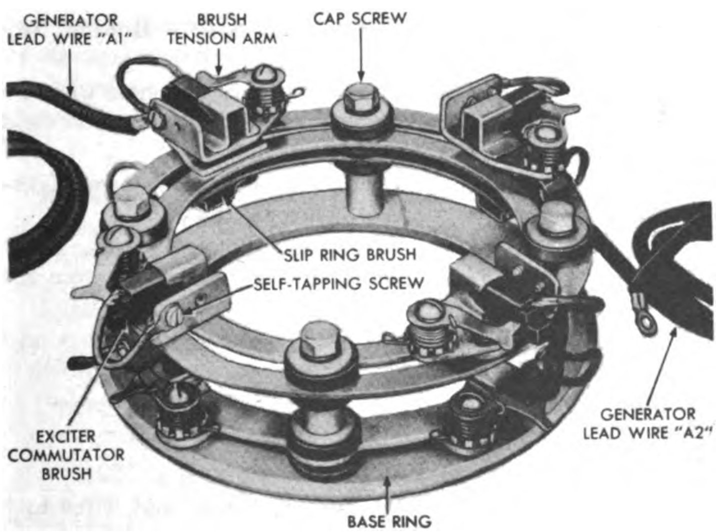
(2) Attach a chain loop to top center of front end of housing with a cap screw. Attach hoist to chain loop. Lift generator assembly and tip it back onto blocks (fig. 148). Shift back block as necessary to keep from crushing lead wires which extend from rear of housing.

(3) Insert two bolts through bolt holes in rotor spider and attach a chain loop to them. Hook loop over hoist and lift rotor from housing (fig. 149).



RA PD 78568

Figure 151—Brush Holder Installed in Bracket



RA PD 78515

Figure 152—Brush Holder Assembled

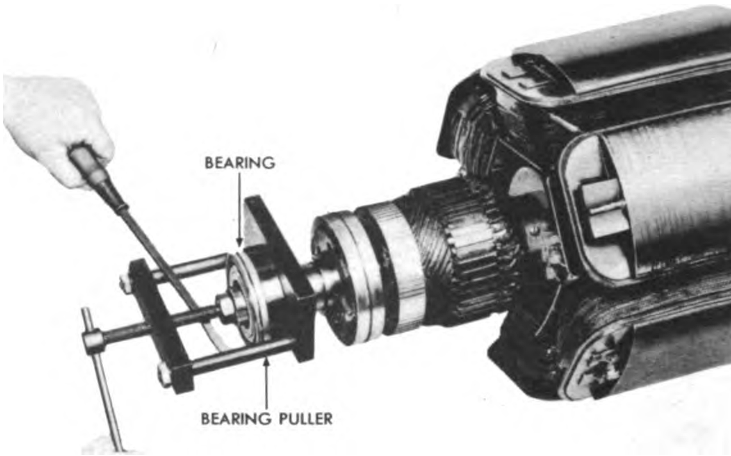


Figure 153—Pulling Bearing From Rotor Shaft

d. Disassemble Exciter Field and Brush Holder Support Bracket.

(1) Remove sealing compound from wire exit hole to free wires for removal. Use care to avoid cutting wires. Pull exciter field coil lead wire through hole into inside of bracket.

(2) Disconnect exciter field coil lead wire from lower right-hand commutator brush holder (opposite wire exit hole).

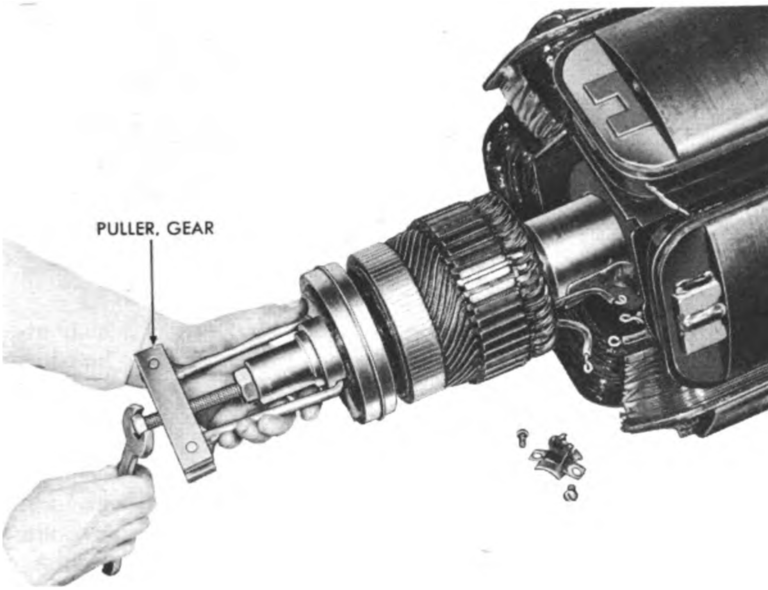
(3) Remove the 4 exciter field coil pole piece bolts. Lift the 4 connected field coils, 4 pole pieces, and 16 insulators from bracket (fig. 150).

(4) Prick-punch brush holder base ring and bracket at adjacent points to facilitate assembly. Loosen the two set screws which clamp holder in bracket, with an offset screwdriver (fig. 151). Lift holder assembly from bracket.

e. Disassemble Brush Holder Assembly (fig. 152).

(1) Remove all screws which attach brush lead wires to brush holders. Lift all brushes and generator lead wires "A1" and "A2" from brush holders.

(2) Remove the four cap screws which secure the entire assembly to base ring. Remove washers, spacers, and bushings.



RA PD 86598

Figure 154—Exciter Armature

(3) Remove the two screws which attach each commutator brush holder to ring assemblies. Lift holders from rings.

(4) Unscrew nut and remove screw from hub of each brush tension arm. Lift arm, spring, special washer, and bushing from each holder.

f. **Disassemble Front Fan Assembly.** Remove the 4 nuts, lock washers, and bolts which attach flexible coupling disks to fan. Lift the 17 disks from fan.

g. **Disassemble Rotor Assembly.**

(1) Rotor is statically and dynamically balanced. Do not disassemble more than necessary for repair or replacement of parts. When replacing parts, select new part of as near same weight as old part as possible in order to preserve balance. Pull bearing from rear end of rotor shaft (fig. 153).

(2) Press flexible coupling spider from front end of shaft. Tap key from shaft.

(3) Disconnect slip ring to revolving field coil wires at connection adjacent to field coils. Tag or mark wires to expedite connecting them in same order at time of assembly. Install a gear puller on

armature sleeve in holes drilled for the purpose at time of manufacture. Pull armature from shaft. Tap key from keyway in shaft.

(4) Melt solder which attaches revolving field coil wires to slip rings (one wire on each ring). Free wires from slip rings by picking off any insulating compound which may cause wires to adhere. Remove two diagonally opposite screws from end of slip ring assembly. Using these screw holes to attach gear puller, pull slip ring assembly from sleeve. Remove remaining four screws and separate end rings, insulating rings, and slip rings from separator.

h. Disassemble Housing and Stator Assembly (fig. 168).

(1) Remove the eight cap screws and lock washers which attach generator terminal box cover to housing. Lift cover from housing. Remove, in order given, nut, lock washer, link, nut, lock washer, and flat washer from each terminal bolt. Lift terminal designation plate from terminal bolts. Lift flat washers from terminal bolts. Mark all wires connected to terminal bolts with a steel scribe to make correct assembly easier. Remove nut, lock washer, and flat washer from each terminal bolt. Push bolts in as necessary and free wires from bolts. Remove the four cap screws and lock washers which attach mounting plates. Lift terminal plate from housing. Pull terminal bolts from terminal plate. Slide flat washers from terminal bolts. Slide U-shaped copper links from "O" terminal bolts. Remove the two nuts, two lock washers, two bolts, and eight flat washers which attach each of the two mounting plates to terminal base plate. Lift mounting plates from base plate.

(2) Remove sealing compound from wire exit hole in housing and pull metering current transformer lead wires into inside of housing. Slide metering current transformers from "A" and "2A" stator lead wires and from "C" and "2C" stator lead wires. Pull generator lead wires marked "A," "B," "C," and "O" from housing wire exit hole.

(3) Pick the two pieces of insulation from end of stator within rear end of housing.

83. INSPECTION.

a. Cleaning. Blow dirt from windings with compressed air. Clean metal parts with dry-cleaning solvent and dry with compressed air. Do not get solvent on coils or wires.

b. General.

(1) Inspect all castings to see if any are cracked or broken. Check condition of threads in all tapped holes. Inspect air passages to see if they are obstructed.

(2) Check condition of all keys and keyways to see if keys are bent, broken, or burred, or if keyways are spread or burred.

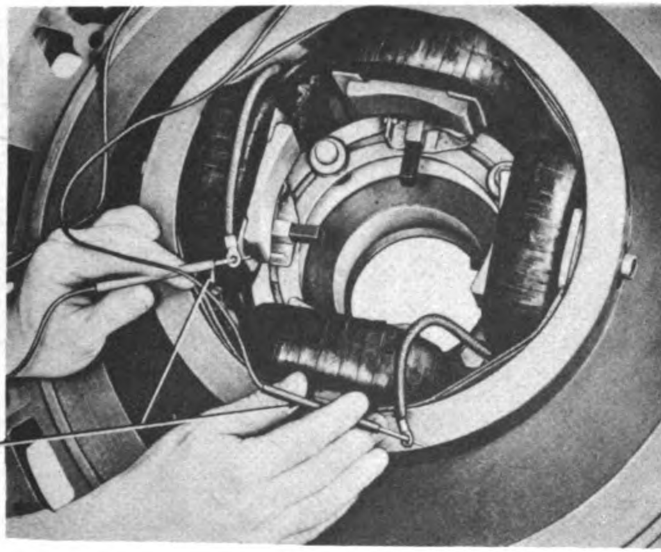


Figure 155—Checking Exciter Field Coils for Open Circuit

(3) Inspect all bolts, nuts, screws, and washers to see if any are bent, broken, burred, or have stripped threads.

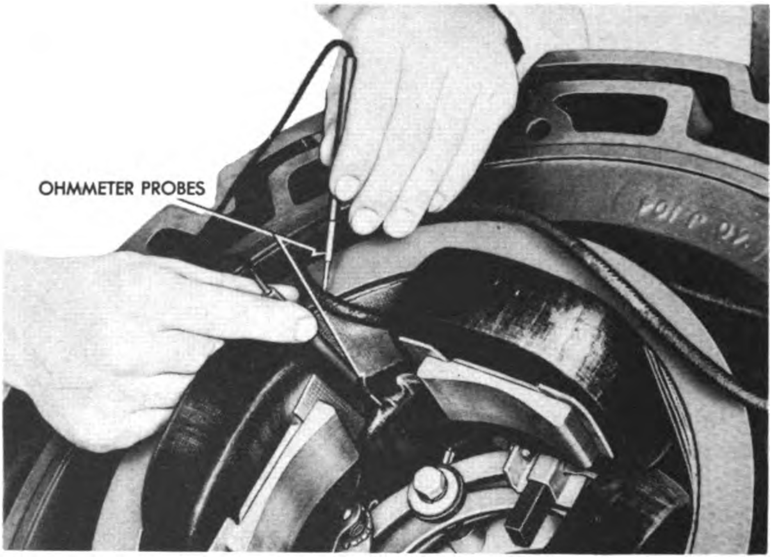
(4) Check condition of insulation on all wires and coils. Notice if it has been damaged by accident or deteriorated from age or adverse weather conditions. Signs of heat on coils or wires indicate a short circuit.

(5) Examine rear fan cover to see if it is bent or broken or if screen attaching welds are loosened.

(6) Check condition of disks in flexible coupling to see if any are broken.

c. Exciter Field and Brush Holder Support Bracket Assembly.

(1) Test exciter field coils for an open circuit with coils installed in bracket (fig. 155) or removed from bracket. Touch one probe of test lamp on tip of lead wire from coil to exciter brush. Touch other probe to tip of generator lead wire from coil to exciter brush. Touch other probe to tip of generator lead wire "F." If lamp lights, no open circuit is present. Failure of lamp to light indicates an open circuit. Remove insulation from connections where coils are joined and test coils individually to locate faulty coil.



RA PD 78555

Figure 156—Checking Exciter Field Coils for Short Circuit

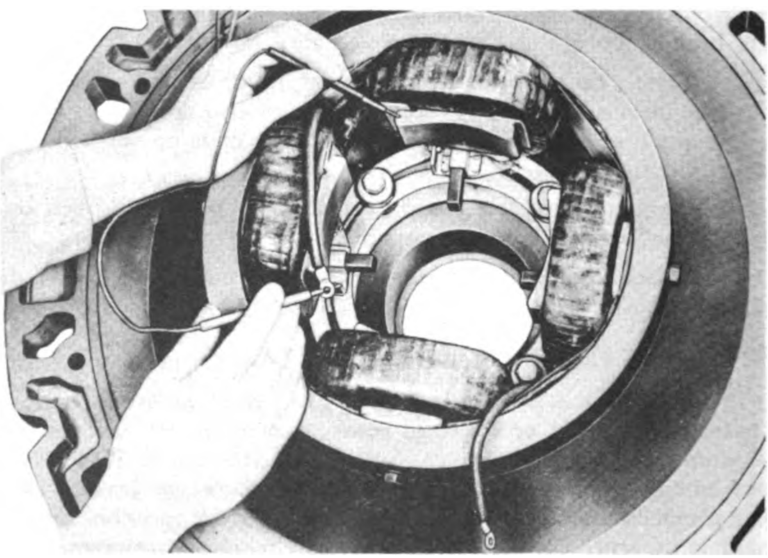


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Figure 157—Checking Exciter Field Coils for Ground

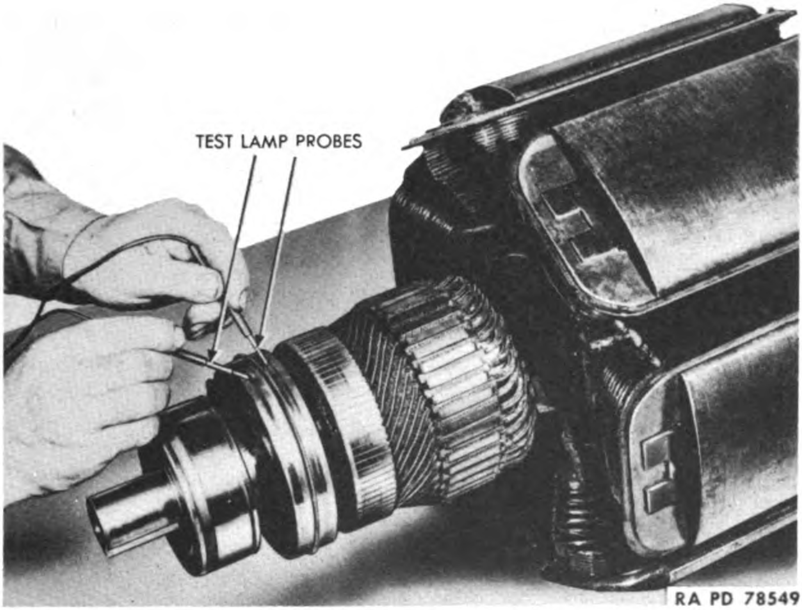
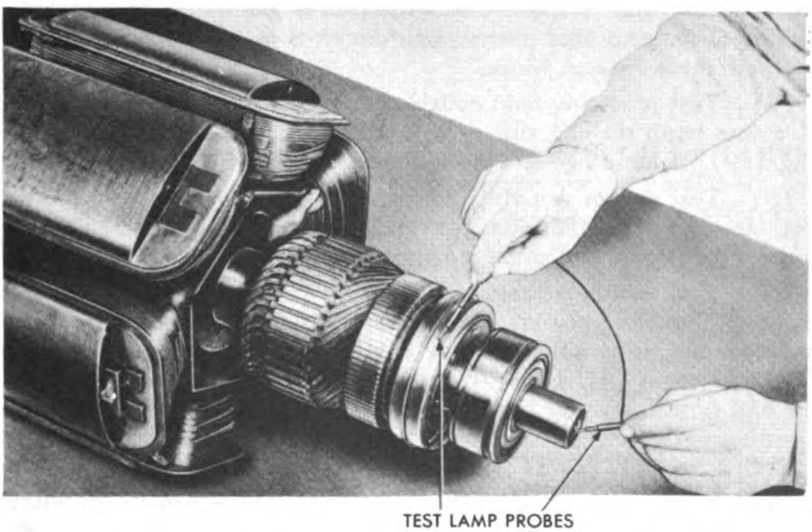


Figure 158—Checking Revolving Field Coils for Open Circuit



RA PD 78523

Figure 159—Checking Revolving Field Coils for Ground

(2) Test individual exciter field coils for short circuits and open circuits with an ohmmeter equipped with sharp pointed probes (fig. 156). A short circuit is indicated in any coil which has an appreciably lower resistance than the others. An open circuit is indicated in any coil which shows an infinite resistance.

(3) Test exciter field coils for a ground (fig. 157). Hold one probe of test lamp to tip of lead from coils, touch other probe to pole piece of coil. If lamp lights, coils are grounded. NOTE: *This test is made with field coils installed in support bracket.*

(4) Inspect all brushes to see if any are broken or worn out (three-quarters inch long or less).

(5) Inspect brush springs to see if they are bent, broken, or weakened.

(6) Examine all insulating washers and bushings to see if they are broken or otherwise damaged.

(7) Check condition of rings, holders, and spacers to see if any are bent, broken, or worn.

d. **Rotor Assembly.**

(1) Test revolving field coils for an open circuit (fig. 158). Place one probe of test lamp on each slip ring. Failure of lamp to light indicates an open circuit. In case an open circuit is indicated, remove insulation from coil to slip ring lead wires at connections adjacent to coils. Repeat test with probes on bared connections. Failure of lamp to light means open circuit is in coils. If lamp lights, open circuit is in lead wires.

(2) Test revolving field coils for a ground by placing one probe of a test lamp on one slip ring. Touch other probe to rotor shaft (fig. 159). If lamp lights, a ground is indicated.

(3) Test exciter armature for a ground by touching probes of a test lamp to a commutator bar and to rotor shaft (fig. 160). A grounded circuit is indicated if lamp lights.

(4) Test exciter armature for a short circuit by placing it in a growler. Turn on growler. Move steel strip slowly around armature coils, keeping it parallel to rotor shaft and about one-quarter inch from coil cores (fig. 161). Turn off growler and revolve armature one-half turn in growler and test other half of armature. If steel strip vibrates noticeably or is drawn to laminations, a short circuit is indicated.

(5) Inspect commutator bars. Look for burs which might short circuit two adjacent bars. Observe whether or not bars are scored.

(6) Inspect slip rings to see if they are scored (rare). Examine separator to see if it was broken due to improper disassembly.

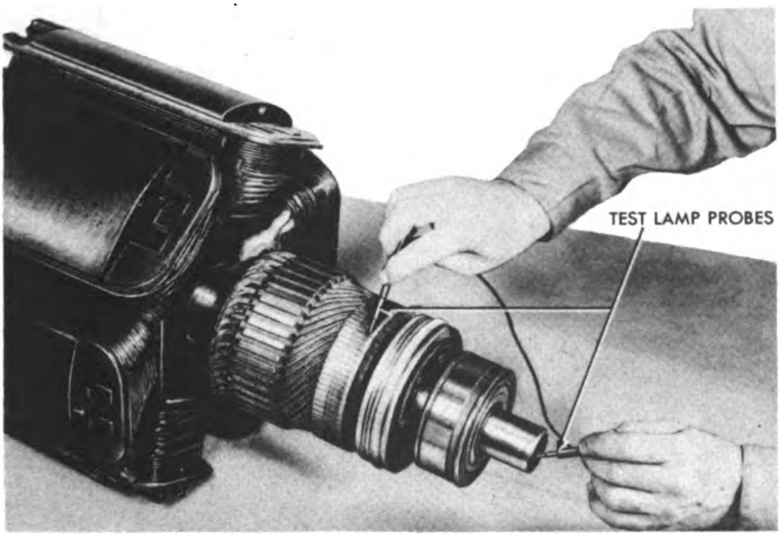


Figure 160—Checking Exciter Armature for Ground

(7) Revolve rotor shaft bearing slowly and listen for noise indicating damage or wear. Test bearing for noticeable side play indicating wear. Structure of bearing makes it impossible to examine races or balls directly.

e. **Housing and Stator.**

(1) Test stator windings for an open circuit as follows (fig. 162): Remove links from terminal bolts in generator terminal box. Test for an open circuit with test lamp by placing probes on terminals "A" and "1A," "B" and "1B," "C" and "1C," "2A" and "2B," and "2A" and "2C," respectively. If lamp fails to light on any test, an open circuit is indicated.

(2) Test stator windings for ground with a test lamp before replacing generator terminal box links (fig. 163). Hold one test lamp probe to frame. Touch other probe to terminals "A," "B," "C," and "O" respectively. A ground is indicated if lamp lights on any test.

(3) Test stator windings for a short circuit with a stator growler (fig. 164). Place growler within stator so steel strip on growler is parallel with and next to stator core laminations. Turn on growler and move slowly around entire inner circumference of stator. If stator windings have a short circuit, growler will "growl" due to vibration of steel strip.

(2) Test individual exciter field coils for short circuits and open circuits with an ohmmeter equipped with sharp pointed probes (fig. 156). A short circuit is indicated in any coil which has an appreciably lower resistance than the others. An open circuit is indicated in any coil which shows an infinite resistance.

(3) Test exciter field coils for a ground (fig. 157). Hold one probe of test lamp to tip of lead from coils, touch other probe to pole piece of coil. If lamp lights, coils are grounded. NOTE: *This test is made with field coils installed in support bracket.*

(4) Inspect all brushes to see if any are broken or worn out (three-quarters inch long or less).

(5) Inspect brush springs to see if they are bent, broken, or weakened.

(6) Examine all insulating washers and bushings to see if they are broken or otherwise damaged.

(7) Check condition of rings, holders, and spacers to see if any are bent, broken, or worn.

d. Rotor Assembly.

(1) Test revolving field coils for an open circuit (fig. 158). Place one probe of test lamp on each slip ring. Failure of lamp to light indicates an open circuit. In case an open circuit is indicated, remove insulation from coil to slip ring lead wires at connections adjacent to coils. Repeat test with probes on bared connections. Failure of lamp to light means open circuit is in coils. If lamp lights, open circuit is in lead wires.

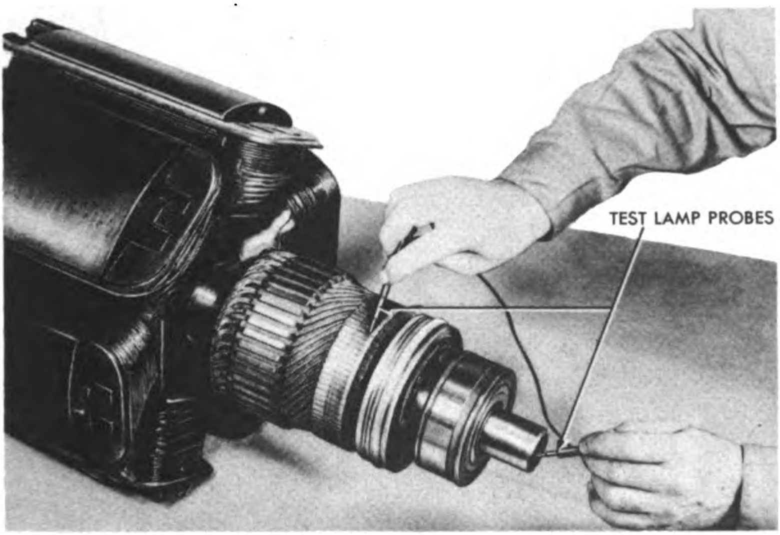
(2) Test revolving field coils for a ground by placing one probe of a test lamp on one slip ring. Touch other probe to rotor shaft (fig. 159). If lamp lights, a ground is indicated.

(3) Test exciter armature for a ground by touching probes of a test lamp to a commutator bar and to rotor shaft (fig. 160). A grounded circuit is indicated if lamp lights.

(4) Test exciter armature for a short circuit by placing it in a growler. Turn on growler. Move steel strip slowly around armature coils, keeping it parallel to rotor shaft and about one-quarter inch from coil cores (fig. 161). Turn off growler and revolve armature one-half turn in growler and test other half of armature. If steel strip vibrates noticeably or is drawn to laminations, a short circuit is indicated.

(5) Inspect commutator bars. Look for burs which might short circuit two adjacent bars. Observe whether or not bars are scored.

(6) Inspect slip rings to see if they are scored (rare). Examine separator to see if it was broken due to improper disassembly.



RA PD 78531

Figure 160—Checking Exciter Armature for Ground

(7) Revolve rotor shaft bearing slowly and listen for noise indicating damage or wear. Test bearing for noticeable side play indicating wear. Structure of bearing makes it impossible to examine races or balls directly.

e. **Housing and Stator.**

(1) Test stator windings for an open circuit as follows (fig. 162): Remove links from terminal bolts in generator terminal box. Test for an open circuit with test lamp by placing probes on terminals "A" and "1A," "B" and "1B," "C" and "1C," "2A" and "2B," and "2A" and "2C," respectively. If lamp fails to light on any test, an open circuit is indicated.

(2) Test stator windings for ground with a test lamp before replacing generator terminal box links (fig. 163). Hold one test lamp probe to frame. Touch other probe to terminals "A," "B," "C," and "O" respectively. A ground is indicated if lamp lights on any test.

(3) Test stator windings for a short circuit with a stator growler (fig. 164). Place growler within stator so steel strip on growler is parallel with and next to stator core laminations. Turn on growler and move slowly around entire inner circumference of stator. If stator windings have a short circuit, growler will "growl" due to vibration of steel strip.

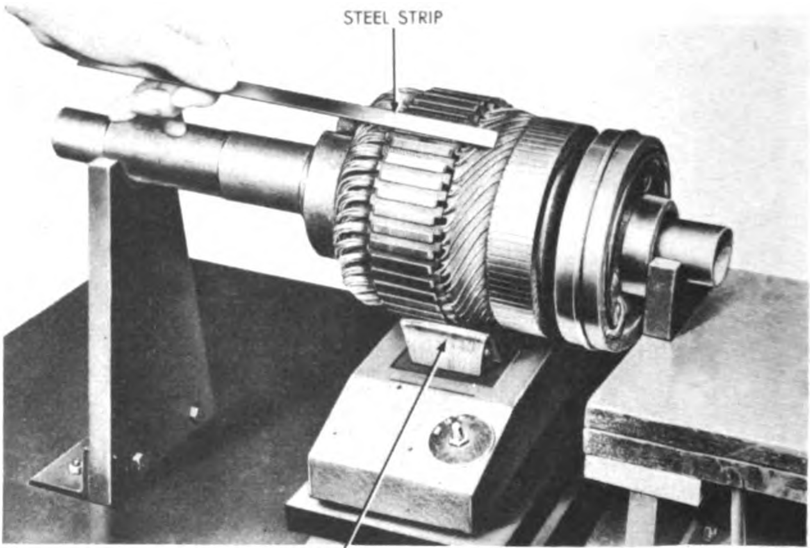


Figure 161—Checking Exciter Armature for Short Circuit

84. REPAIR.

a. General.

(1) Clean up threads which are stripped or burred with a thread tap. Blow or ram all obstructions from air passages.

(2) Replace bent or broken keys. Remove burs from all parts with a fine mill file.

(3) Replace all bolts, nuts, screws, and washers which are bent, broken, or stripped.

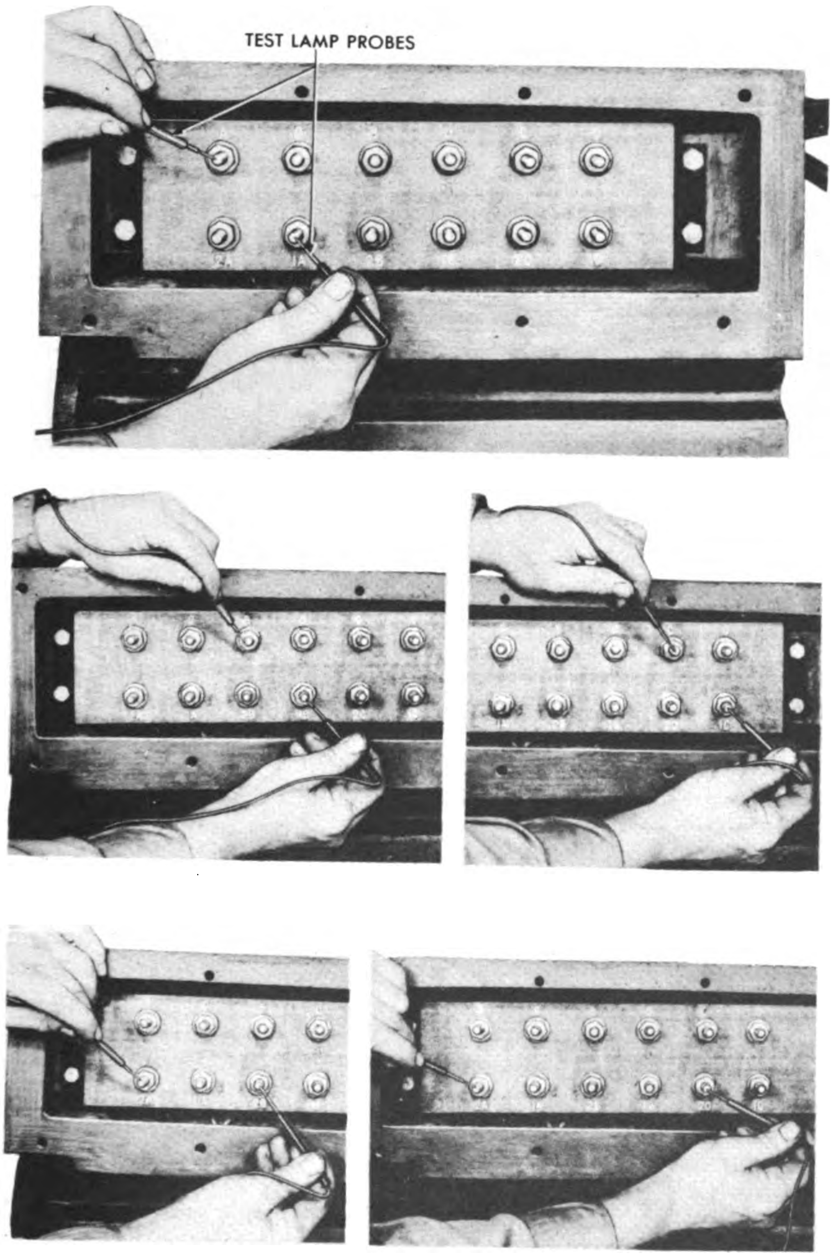
(4) Repair damaged or doubtful insulation by wrapping with tape and/or painting with glyptal synthetic paint if possible. Otherwise, replace coil or wire.

(5) Bump rear fan covers into original shape if bent. Weld covers if torn or if welds have loosened. Replace covers if beyond repair.

(6) Replace broken disks in flexible coupling.

b. Exciter Field and Brush Holder Support Bracket Assembly.

(1) If exciter field coils show an open circuit, short circuit, or ground, check connections and lead wires. If defect is located in leads



RA PD 78566

Figure 162—Checking Stator Windings for Open Circuit

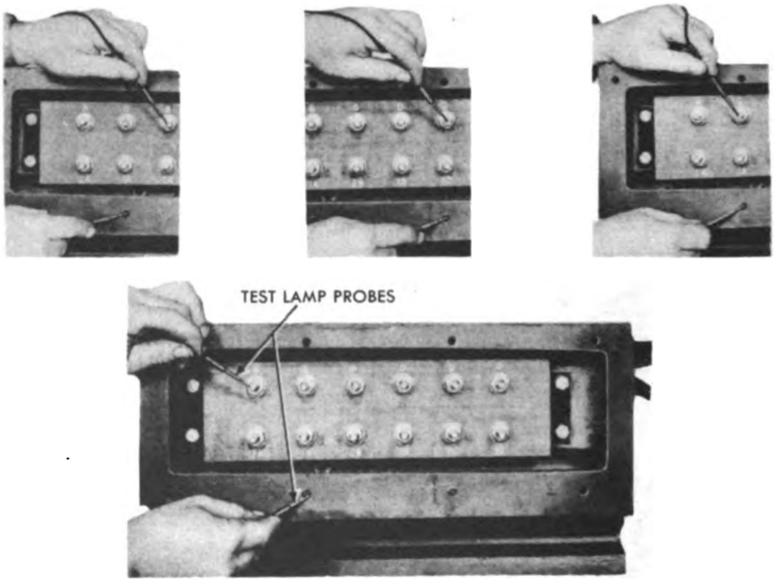


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Figure 163—Checking Stator Windings for Ground

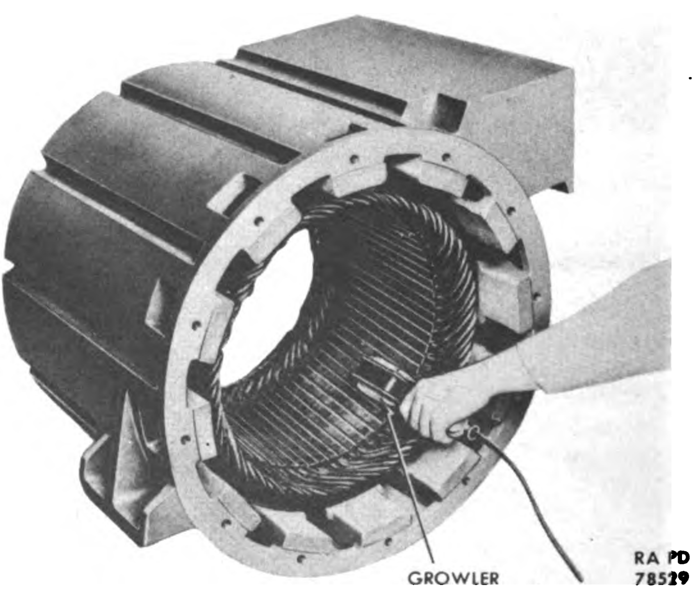


Figure 164—Checking Stator Windings for Short Circuit

or connections, connect and solder wires. Wrap connection in tape and paint with glyptal synthetic paint. If defect is within a coil, replace coil.

(2) Replace brushes which are broken or worn out (three-quarters inch or less in length).

(3) Replace bent, broken, or weakened brush springs.

(4) Straighten or replace metal parts of brush holder. If parts are straightened, check them carefully to see if they have been weakened. Replace broken, worn, or weakened parts.

c. **Rotor Assembly.**

(1) If revolving field coils have an open circuit, short circuit, or ground, carefully inspect lead wires and connections between coils and between coils and slip rings. If defect is found, solder connections, wrap with tape, and paint with glyptal synthetic paint. Otherwise, replace coil assembly or entire rotor.

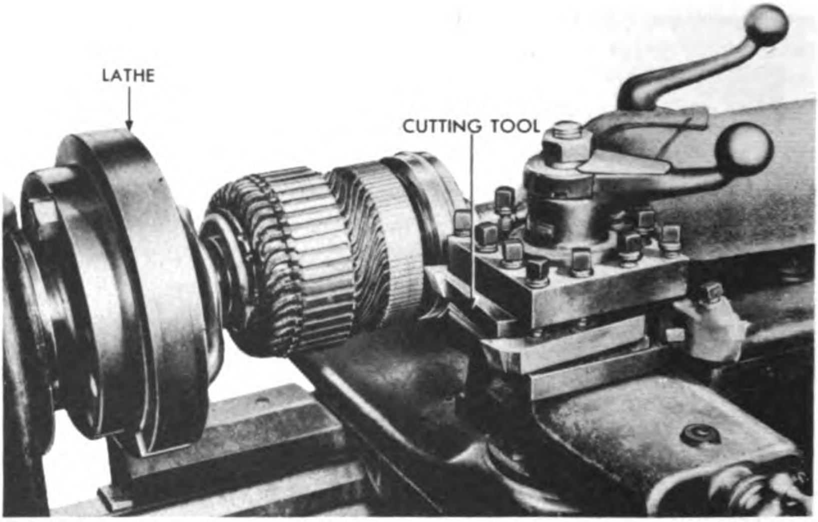
(2) Examine exciter armature if it has an open circuit. If cause is a wire pulled loose from a commutator bar, solder wire to slot in bar. Turn commutator down on a lathe and undercut the mica (step (3), below). Replace armature if short circuited or grounded.

(3) If exciter commutator bars are scored, place rotor assembly in a lathe. Take a cut from commutator bars (fig. 165). Make cut no deeper than necessary to remove all score marks. Hold a piece of flint paper, No. 2/0, against revolving commutator to remove cutting tool marks. With an undercutting machine, undercut mica between commutator bars to a depth of 0.0025 inch (fig. 166).

(4) If slip rings are scored, place rotor in a lathe. Take a cut just deep enough to remove score marks from slip rings. Hold a piece of flint paper, No. 2/0, against slip rings to remove cutting tool marks. Exercise care during entire operation to keep from injuring separator.

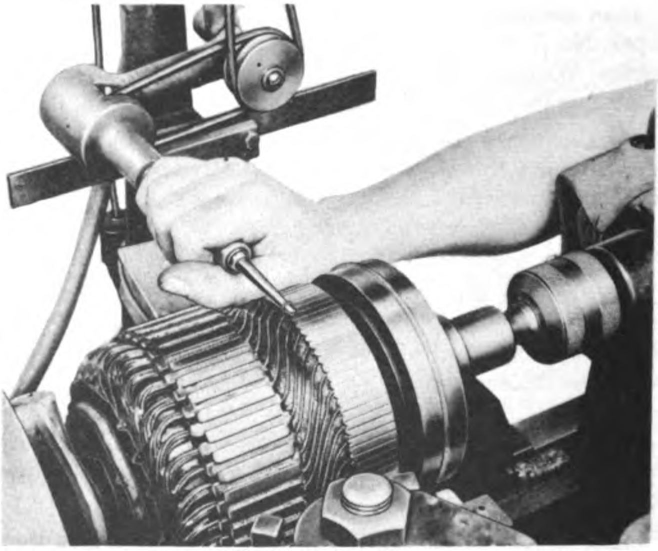
(5) If slip ring separator is broken, melt solder which attaches lead wire from revolving field to outer slip ring, and pry wire loose. Remove the six screws from end ring. Tap threads in two diagonally opposite screw holes in outer ring. Pull end ring from shaft with a gear puller. Lift insulating ring, outer slip ring, and separator from rotor. Install new separator and old slip ring, insulating ring, end ring, and the six screws respectively. Solder lead wire from revolving field coil to outer slip ring.

(6) Replace rotor bearing if noise or play indicates damage or wear. Remove lubrication screw from outer race of new bearing and fill bearing with lubricating grease (special). About 1 cubic inch of grease is required. Install screw.



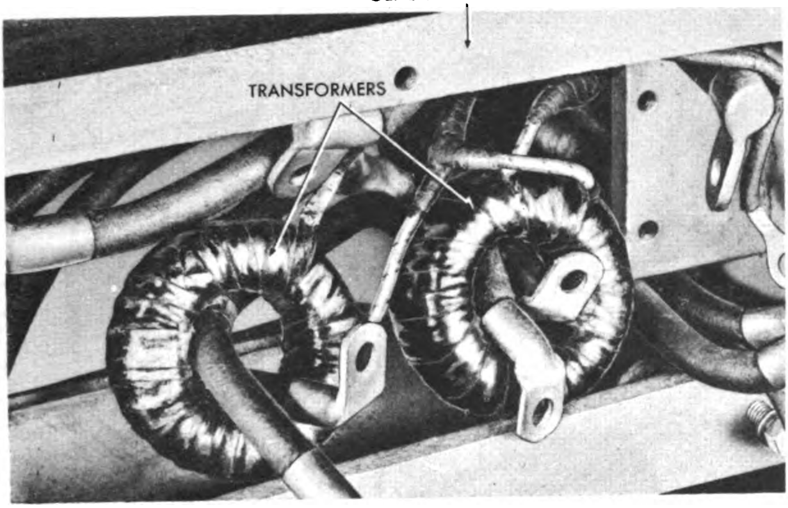
RA PD 78504

Figure 165—Exciter Armature in Lathe To Cut Commutator Bars



RA PD 78528

Figure 166—Undercutting Mica on Exciter Commutator



RA PD 78526

Figure 167—Metering Current Transformers Installed

d. Housing and Stator.

(1) If stator windings have an open circuit, it probably is in leads or connections. Coils themselves are composed of three wires in parallel and it is improbable that all three wires would break. Remove tape and loom from connections and inspect welds. Test leads for an open circuit (par. 22 a). If defective connection or broken lead wire is located, weld wires together. Cover connection with loom and tape. Paint tape with glyptal synthetic paint. If open circuit is within a coil, replace entire stator.

(2) If stator windings are grounded, inspect lead wires and connections for faulty insulation. If uninsulated spot is located, install loom and tape. Paint loom and tape with glyptal synthetic paint. If ground is within a coil, replace stator.

(3) Replace stator if short circuited.

85. ASSEMBLY.

a. Assemble Housing and Stator Assembly (fig. 168).

(1) Position two pieces of insulation between sides of housing and stator at rear end of assembly. Move insulation as necessary to protect stator leads from housing.

(2) Slide metering current transformer (fig. 167) over stator lead wires "A" and "2A." Slide other metering current transformer

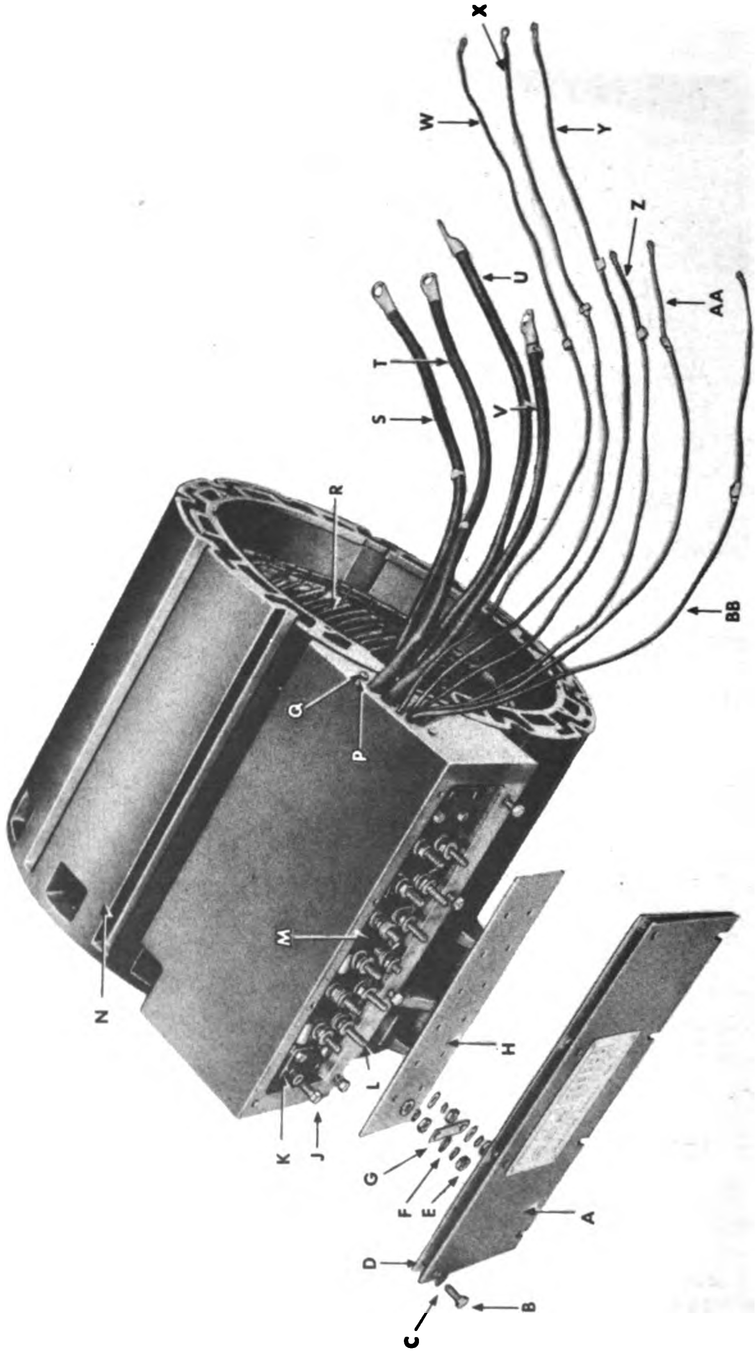


Figure 168—Housing and Stator Partially Disassembled

A—COVER—A318394
B—BOLT—BANX1CA-2
C—WASHER—BECX1K
D—GASKET—A318395
E—NUT, jam, hv., hex., s-fin., S., zn-pltd., 3/8-16NC-2
F—WASHER—BEBX1BK-14
G—LINK—A318388
H—PLATE—B270753
J—SCREW, cap, hex-hd., S., zn-pltd., 3/8-16NC-2 x 1 3/8
K—PLATE—A318392
L—SCREW, special, hex-hd., S., zn-pltd., 3/8-16NC-2 x 2 3/4, thd. full lgh.
M—BLOCK—B181607
N—HOUSING—D83376
P—SPACER—A319025
Q—SCREW—BCNX2CE-2
R—STATOR, ASSEMBLY—D83371
S—WIRE, ASSEMBLY—B271224B
T—WIRE, ASSEMBLY—B271224A
U—WIRE, ASSEMBLY—B271224D
V—WIRE, ASSEMBLY—B271224C
W—WIRE, current transformer to terminal block "3," assembly
X—WIRE, current transformer to te-minal block "4," assembly
Y—WIRE, current transformer to terminal block "8," assembly
Z—WIRE, ASSEMBLY—B271225C
AA—WIRE, ASSEMBLY—B271225B
BB—WIRE, ASSEMBLY—B271225A

RA PD 78438A

Legend for Figure 168—Housing and Stator Partially Disassembled

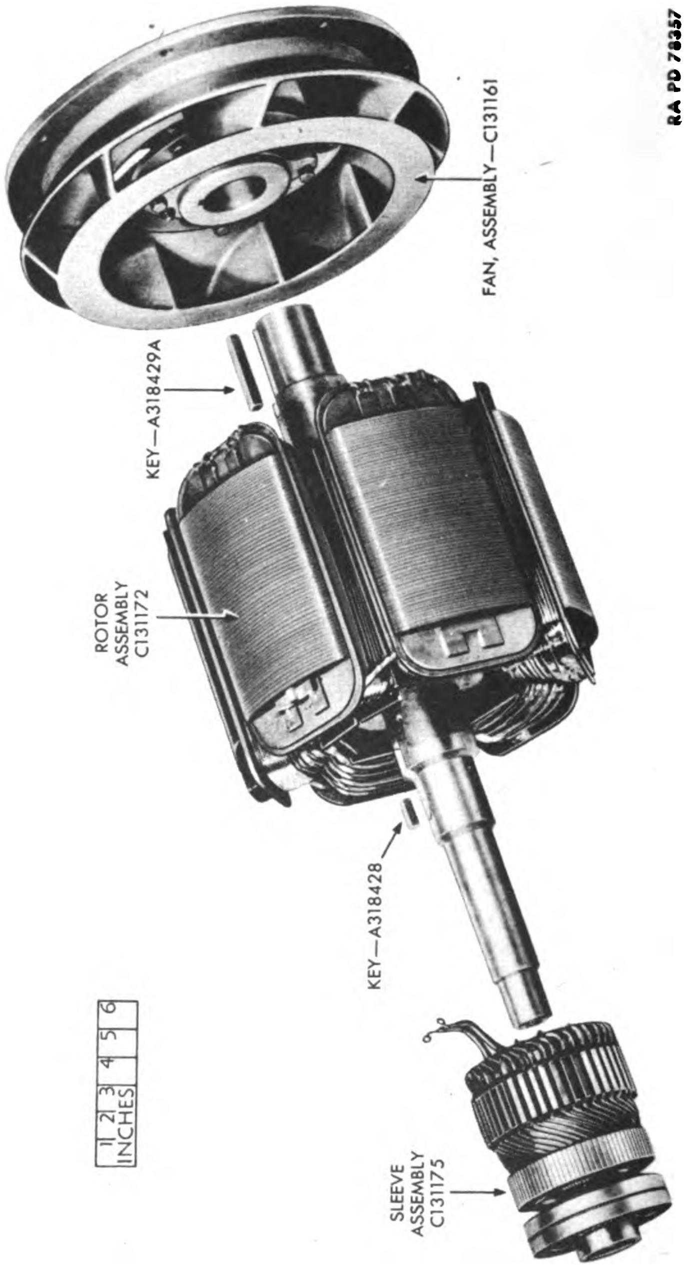


Figure 169—Rotor Disassembled

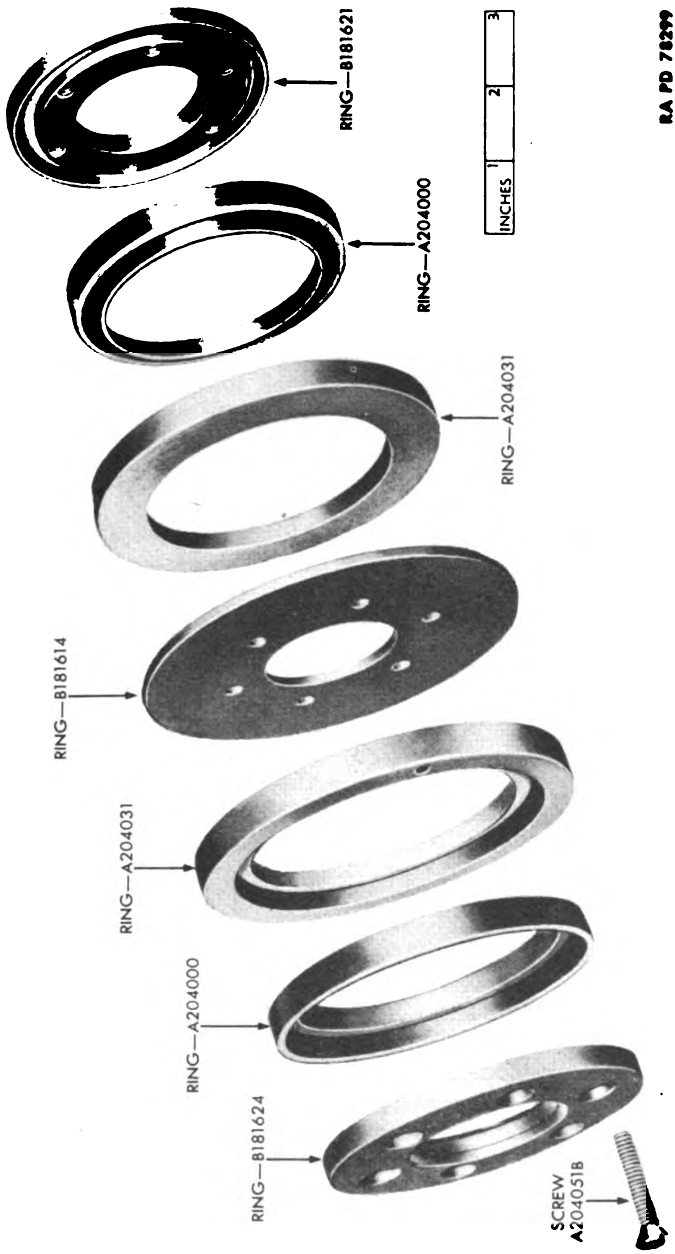


Figure 170—Slip Rings Disassembled

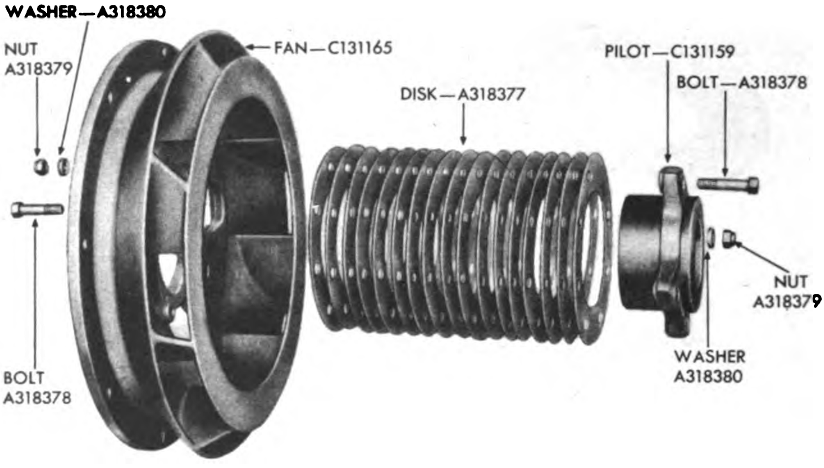


Figure 171—Front Fan Disassembled

over stator lead wires "C" and "2C." Insert generator lead wires "A," "B," "C," and "O" into position through wire exit hole in housing. Work metering current transformer wires out through wire exit hole in housing.

(3) Place a mounting plate in position on end of generator terminal box base plate. Install the eight flat washers, two bolts, two lock washers, and two nuts which secure the plates together. Similarly install remaining mounting plate on other end of terminal base plate. Position the two U-shaped copper links on rear of plate so they connect the three "O" terminal bolts. Insert "O" terminal bolts through holes in copper links and through "O" holes of plate. Slide a flat washer onto all remaining terminal bolts. Insert remaining terminal bolts into terminal bolt holes from rear of plate. Position plate within housing. Work lug of stator lead wire "2A" onto "2A" terminal bolt and install flat washer, lock washer, and nut. Similarly connect stator lead wires "1A," "2B," "1B," "2C," "1C," and "O" to their respective terminal bolts. Similarly connect generator lead wires "A," "B," "O," and "C" to their respective terminal bolts. Force terminal plate back into position within housing. Install the four lock washers and cap screws which attach terminal plate to housing. Shim all terminal bolts with flat washers as necessary to provide an even backing for terminal designation plate. Slide designation plate onto terminal bolts. Install flat washer, lock washer, and nut on each terminal bolt. Connect links with lock washers and nuts. Position of links is governed by output voltage desired (par. 87 a and b). Position terminal box

cover on housing. Install the eight lock washers and cap screws which attach cover.

(4) Fill wire exit hole with sealing compound composed of a thick mixture of asbestos flour and varnish.

b. **Assemble Rotor Assembly** (fig. 169).

(1) Assemble and install slip rings as follows (fig. 170): Position an insulating ring in each slip ring. Place separator between slip rings. Position end rings on insulating rings. Install the six screws which hold the assembly together. Press assembly onto exciter armature sleeve. Solder on revolving field lead wire to each slip ring.

(2) Tap key into keyway in rotor shaft. Aline keyways of shaft and exciter armature sleeve. Press armature onto shaft. Connect each revolving field coil lead wire to coil lead with stove bolt and nut. Solder nut to bolt. Paint connections with glyptal synthetic paint. Protect wires with insulation and clamp to shaft sleeve with clamp and screws provided for the purpose.

(3) Tap key into keyway on front end of rotor shaft. Heat flexible coupling spider and press onto shaft over key.

(4) Press bearing onto rear end of shaft. Be sure to install bearing so removable snap ring and retainer are to rear.

c. **Assemble Front Fan** (fig. 171).

(1) Position the 17 steel disks which make up flexible coupling on front fan.

(2) Install the four bolts, washers, and special nuts which attach disks to fan.

d. **Assemble Brush Holder Assembly.**

(1) SLIP RING BRUSH HOLDER.

(a) On screw BCNX2CH-2, position bushing A204005, lever B181040, spring A204067, and washer A204003.

(b) Install screw into screw hole in holder B178783, and install nut A204004 on screw.

(c) Similarly assemble the three remaining holders.

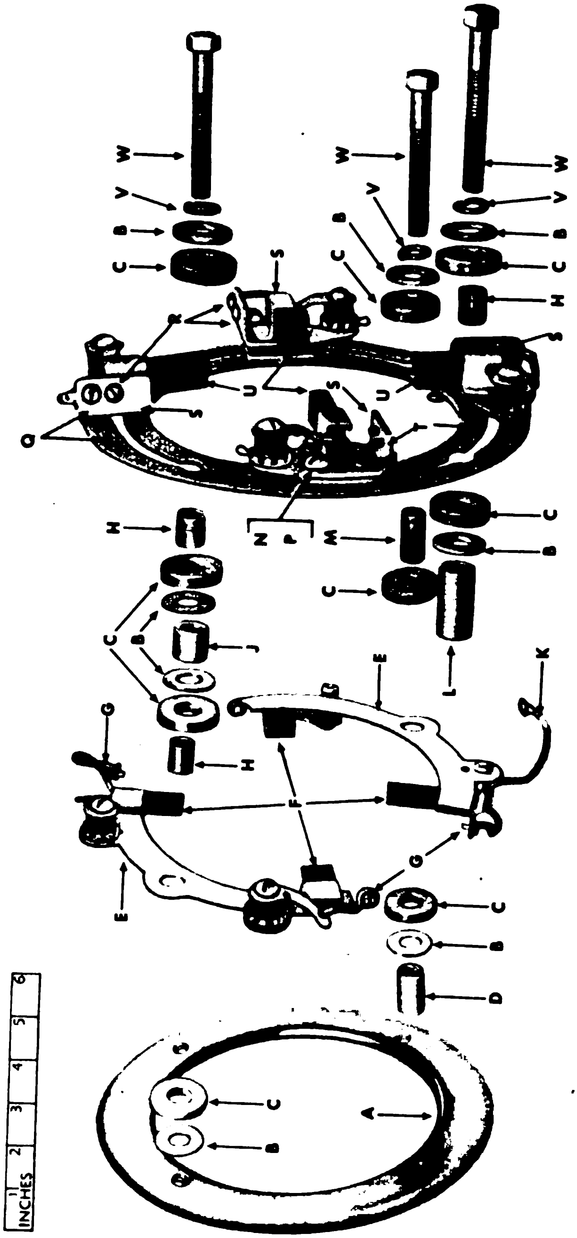
(d) If new holders B178783 are used, tap threads in brush lead screw holes with a No. 6-32 by 3/16-inch self-tapping screw.

(2) EXCITER BRUSH SPRING BRACKETS.

(a) On screw BCNX2CH-2 position bushing A204005, arm B178782, spring A204067, and washer A204003.

(b) Install screw into screw hole in holder B178779, and install nut A204004 on screw.

(c) Repeat steps *(a)* and *(b)*, above, to assemble the remaining three brackets.



RA PD 78208

Figure 172—Brush Holder Disassembled

A—RING—A204015
B—WASHER—BEBX2D-2
C—WASHER—A204045
D—SPACER—A204054
E—HOLDER, ASSEMBLY—B178787
F—BRUSH—B178789
G—SCREW, SELF-TAPPING, BDG-HD., S., TN-PLTD., NO. 6 (.138)-32NC-2 x 1/4
H—BUSHING—A204046
J—SPACER—A204055
K—WIRE, SGLE-COND., NO. 12 x 4 1/2 LONG
K—TERMINAL—A321367
L—SPACER—A204053
M—BUSHING—A204056
N—SCREW—BCNX2CC-2
P—WASHER—BECX1G
Q—RING, ASSEMBLY—B178891
R—SCREW—BCXX3EA-14
S—BRACKET, ASSEMBLY—B178812
T—HOLDER, ASSEMBLY—B178813
U—BRUSH—B178788
V—WASHER—BECX2K-2
W—SCREW—BCAX1CK-2

RA PD 78208A

Legend for Figure 172—Brush Holder Disassembled

(3) INSTALL EXCITER BRUSH SPRING BRACKETS (fig. 172).

(a) Place two exciter brush spring brackets in position on inner ring holder B178813, and attach each with two lock washers and screws.

(b) Similarly install the two remaining exciter brush spring brackets on outer ring B178891.

(4) Place base ring (A)* flat on bench, beveled side up.

(5) On cap screw (W), place lock washer (V), flat washer (B), fiber washer (C), fiber bushing (H), fiber washer (C), flat washer (B), steel spacer (J), flat washer (B), fiber washer (C), fiber bushing (H), brush holder assembly (E), fiber washer (C), and flat washer (B). Start screw into screw hole in base ring (A).

(6) On another cap screw (W), place lock washer (V), flat washer (B), fiber washer (C), fiber bushing (M), fiber washer (C), brush holder assembly (E), fiber washer (C), flat washer (B), and steel spacer (D). Start cap screw into screw hole in base ring (A) opposite screw hole used in step (5), above.

(7) With base ring (A) still flat on bench, carefully remove cap screw installed in step (5), above, with three washers (V, B, and C) on cap screw. This leaves fiber bushing (H), two washers (C and B), steel spacer (J), two washers (B and C), and fiber bushing (H) in place on base ring (A).

(8) Hook outer ring (Q) over cap screw (W) installed in step (6), above. Turn ring so brush holder is to left of screw. Be sure to place ring between the two top fiber washers (C) nearest head of screw. Rest other side of ring on fiber washer (C) in place over screw hole on other side of base ring (A).

(9) Insert inner ring holder assembly (T) between two top fiber washers (C) on cap screw (W) installed on base ring (A). Arrange ring holder assembly so brush brackets are on top and one-quarter of circumference from brush brackets on outer ring (Q). Rest other side of ring holder assembly on fiber washer (C) in place over screw hole on other side of base ring (A).

(10) Insert cap screw (W) with three washers (V, B, and C), which were removed in step (7), above, between outer ring (Q) and inner ring holder (T) and through washers, bushings, and spacers left in position in step (7), above. Tighten screw securely into base ring (A).

(11) On another cap screw (W), place lock washer (V), flat washer (B), fiber washer (C), and fiber bushing (H). Place screw through space between outer ring assembly (Q) and inner ring holder assembly (T). On end of cap screw, place fiber washer (C), flat washer (B), and steel spacer (L). Tighten screw in base ring (A).

*Refer to figure 172.

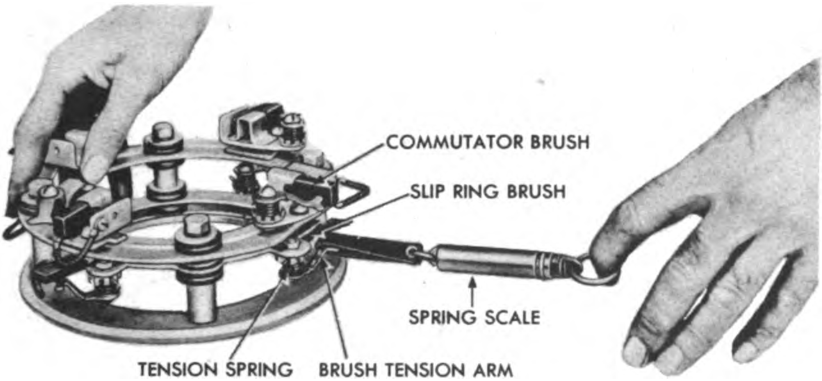


Figure 173—Measuring Brush Spring Tension

(12) Repeat step (11), above, to install remaining cap screw (W).

(13) Tighten cap screw (W) installed in step (6), above.

(14) Place a brush (U) in each of the four exciter brush spring bracket assemblies with brush turned so lead wire is on side of brush adjacent to outer ring assembly (Q). Place tension arm against side of brush near top of brush so brush is held up in holder. Connect lead wire from each brush with screw in outer hole on each holder.

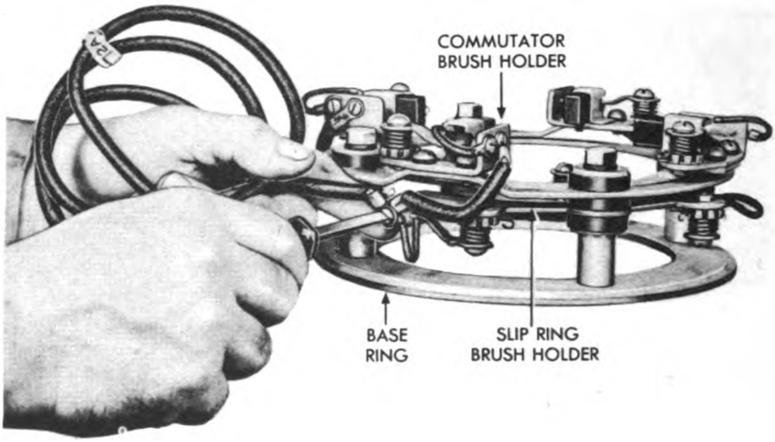
(15) Place a brush (F) in each of two guides on each of the two slip ring brush holders, with brush turned so brush lead wire is adjacent to screw hole. Place tension lever against side of brush near top so brush is held up in guide. Attach brush lead wires to holders with screws provided for the purpose (fig. 172).

(16) Measure tension of each brush tension arm with a spring scale (fig. 173). Hook scale to end of arm, pull scale, and observe reading. Move end of tension springs to right or left to decrease or increase tension. Adjust slip ring brushes to 8-ounce tension and commutator brushes to 12-ounce tension.

(17) Turn assembly so slip ring brush holder (E) assembled closest to ring (A) faces you. Connect wire from exciter brush holder over right-hand end of commutator brush holder to slip ring brush holder (fig. 174).

(18) Turn assembly so slip ring brush holder farthest from base ring faces you. Connect wire from commutator brush holder over left end of slip ring brush holder to slip ring brush holder. Also connect generator lead wire "2A" to slip ring brush holder (fig. 174).

(19) Connect generator lead wire "1A" to commutator brush holder over right end of slip ring brush holder (fig. 175).



RA PD 78508

Figure 174—Connecting Generator Lead Wire "2A"

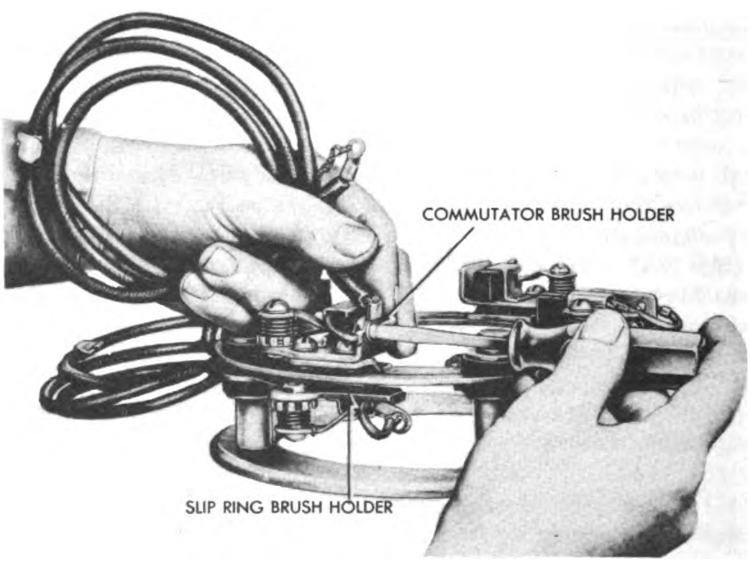


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Figure 175—Connecting Generator Lead Wire "1A"

e. Assemble Exciter Field and Brush Holder Support Bracket (fig. 176).

(1) Position brush holder assembly in exciter field and brush holder support bracket. Turn holder so generator lead wire "A2" point of attachment is adjacent to left-hand set screw. Tighten the two set screws which secure holder to bracket.

(2) Wrap pole piece large insulator around each pole piece and insert pole pieces into exciter field coils. Work a pole piece small insulator under each shoulder of pole pieces between coils and pole pieces. Position coils in bracket with coils which are not connected to each other to right-hand side of bracket. Install pole piece screws just tight enough to hold coils in place. Work the four bracket insulators between coils and bracket, but not under pole pieces. Tighten pole piece bolts securely (fig. 177).

(3) Connect short lead wire from exciter field coils to lower right-hand commutator brush holder B178779.

(4) Work long exciter field coil lead wire out through wire exit hole in bracket. Work generator lead wires "2A" and "1A" out through same hole. Fill hole with a sealing compound of 55 percent asbestos flour and 45 percent shellac varnish by weight.

f. Install Rotor (fig. 149).

(1) Insert two bolts through opposite bolt holes in rotor spider and attach a chain loop to bolts. Attach a hoist to chain loop and lift rotor.

(2) Place stator and housing assembly on its back end on blocks under hoist.

(3) Lower rotor into position within stator and housing. Tip generator over to horizontal position.

g. Install Front Fan (figs. 171 and 176). Position fan with disks attached to it to pilot which is sweated to rotor shaft. Install the four bolts, washers, and special nuts which attach laminated coupling disks to shaft.

h. Install Exciter Field and Brush Holder Support Bracket and Rear Fan (fig. 176).

(1) Check all brushes to be sure they are lifted up in holders so tension levers hold them there.

(2) Position bracket on rear of generator, making certain that bearing seats properly (flush with outside). Install the eight lock washers and cap screws which attach bracket to housing.

(3) Reach through brush cover openings and lift each brush tension lever sufficiently to free brushes. Push brushes into contact with commutator or slip rings. Install brush covers.

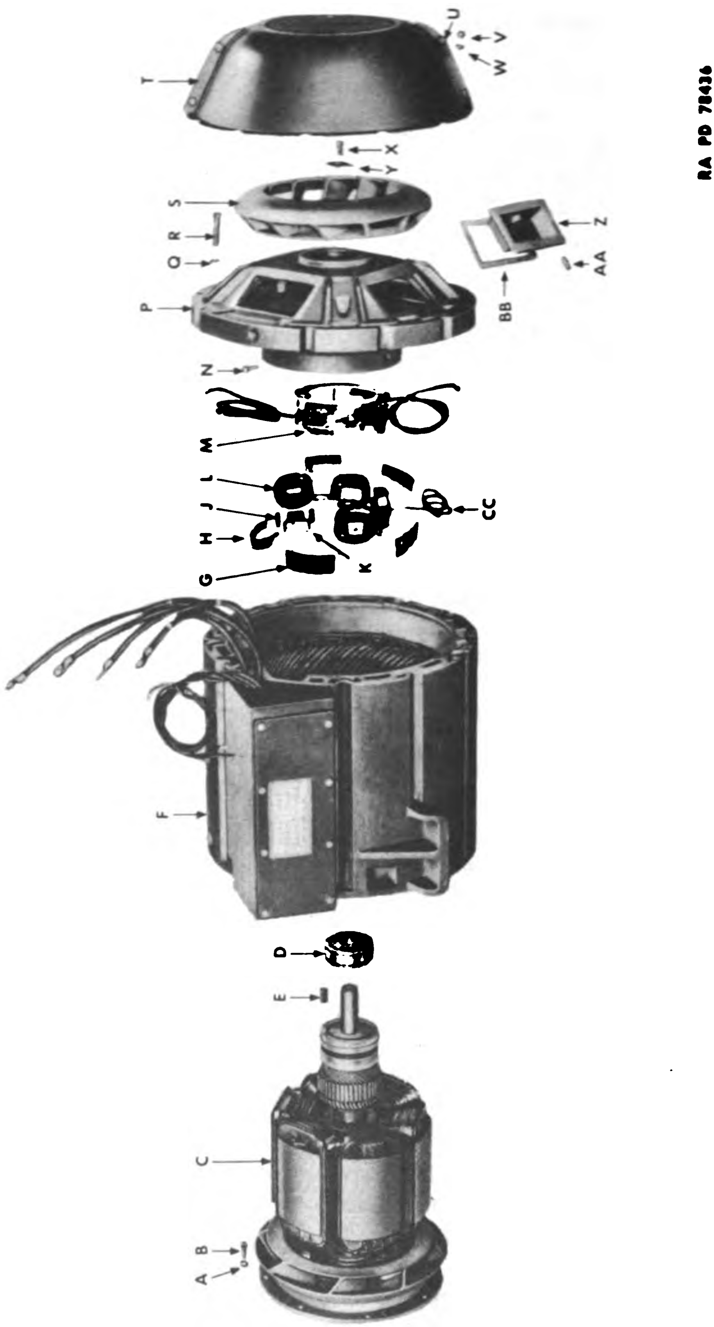


Figure 176—A-C Generator—Partially Exploded View

A—WASHER—BECX1M

B—SCREW, cap, hex-hd., S., zn-pltd., ½-13NC-2 x 1⅜

C—ROTOR, ASSEMBLY—C131184

D—BEARING—NH-3610-J

E—KEY—A318428

F—HOUSING, main generator, assembly

G—INSULATOR—HBC-40J-66

H—INSULATOR—HBC-40J-65

J—INSULATOR—A318442

K—PIECE—B181617

L—COIL, ASSEMBLY—C131177

M—HOLDER, ASSEMBLY—D83469

N—BOLT, hex-hd., s-fin., alloy-S., zn-pltd., ⅜-16NC-2 x 1⅝

P—BRACKET—D83368

Q—WASHER—BECX1L

R—BOLT—BANX1DM-2

S—FAN—C131162

T—GUARD, main generator rotor fan

U—NUT—BBCX1C-2

V—BOLT, hex-hd., s-fin., alloy-S., zn-pltd., ⅜-16NC-2 x 9/16

W—WASHER—BECX1K

X—SCREW—BCDX1BB-2

Y—WASHER—A318381

Z—COVER—B181610

AA—SCREW, set, socket-hd., cone-pt., S., ½-13NC-2 x 1¼

BB—GASKET—A318396

CC—WIRE, ASSEMBLY—B271223C

RA PD 78436A

Legend for Figure 176—A-C Generator—Partially Exploded View

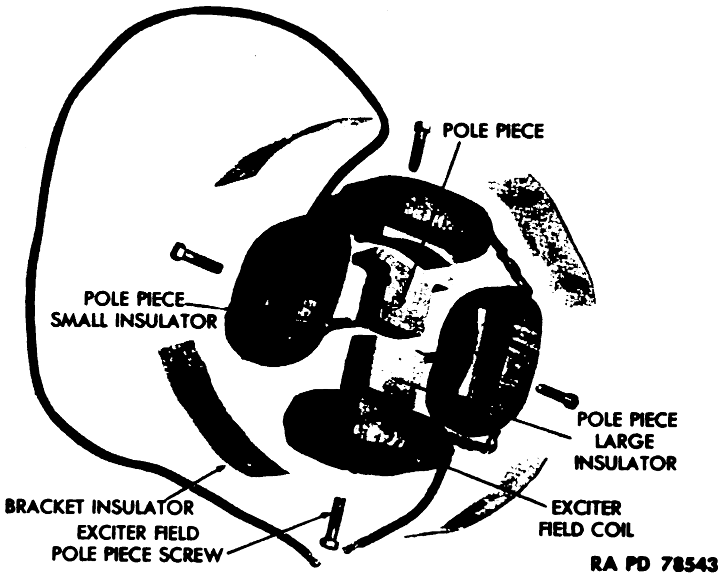


Figure 177—Exciter Field Coil Installation

(4) Tap key into position in keyway on rear of rotor shaft. Tap rear fan into place on end of shaft over key. Install special washer and screw which secure rear fan to shaft.

86. INSTALLATION.

a. Lower generator into position on unit behind engine and inch ahead until in position against engine (fig. 143).

b. Hand-crank engine to aline prick-punch marks on flywheel and fan (fig. 142). If prick-punch marks were not made at time of removal, it will be necessary to crank engine until screw holes line up.

c. Install the eight lock washers and screws which attach generator fan to engine flywheel.

d. Remove hoist and install the 12 lock washers and screws which attach engine bell housing to generator housing. Long cap screw goes in top center hole.

e. Install the four special washers, cap screws, lock washers, and nuts which secure generator to main frame.

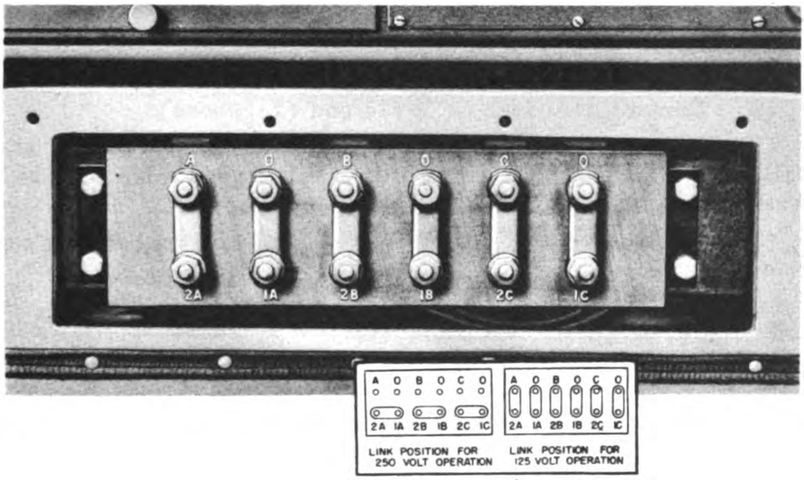


Figure 178—Generator Terminal Box

f. Position the two bell housing cover plates over handholes on bell housing. Install the eight lock washers and cap screws which attach each plate to bell housing.

g. Place fan guard in position on rear end of generator. Install the lock washers and screws which secure guard to generator.

h. Remove blocking placed between engine bell housing and frame to support engine.

i. Install rear upright frame, battery and tool box shelf, instrument panel (par. 96), gasoline tank (par. 37 f), both rear side panels, hood, and all four doors.

87. ADJUSTMENTS.

a. Adjust Unit To Deliver 125-volt Output (fig. 178).

(1) Remove the eight cap screws and lock washers which attach generator terminal box cover to left side of generator housing. Lift cover from housing.

(2) Remove nuts, lock washers, and links from terminal bolts.

(3) With links, connect terminal bolts "A" and "2A," "O" and "1A," "B" and "2B," "O" and "1B," "C" and "2C," and "O" and "1C." Secure links to terminal bolts with lock washers and nuts.

(4) Attach cover to housing with the eight lock washers and cap screws.

b. Adjust Unit To Deliver 250-volt Output (fig. 178).

(1) Remove links (subpar. a (1) and (2), above).

(2) With links, connect terminal bolts "2A" and "1A," "2B" and "1B," and "2C" and "1C." Secure links to terminal bolts with lock washers and nuts.

(3) Attach cover to housing with the eight lock washers and cap screws.

c. Adjust Voltage Output Slightly. If voltage is "OFF" slightly under load and if check-up reveals no mechanical fault, proceed as follows:

(1) Loosen the two set screws which secure generator brush holder assembly to exciter field and brush holder support bracket.

(2) Turn brush holder counterclockwise (viewed from rear of unit) to lower voltage; clockwise to raise voltage. Tighten set screws and test unit. Repeat adjustment and test until correct under load voltage is obtained.

Section II

POWER RECEPTACLES AND LOAD TERMINAL BOX

88. 200-AMPERE POWER RECEPTACLES.

a. Description (figs. 179 and 180). There are two 200-ampere duty three-pole receptacles. Each receptacle body is of elbow type steel construction. Attaching end of receptacle body has a square-shaped flange with four screw holes. The other end has a round nut which attaches a chained cover. The three terminals are secured in the insulation which is housed within body. The assembly is retained by a split ring.

b. Removal (fig. 180).

(1) Remove nut and external tooth lock washer from terminals "A," "B," and "C" on rear of load terminal box. Remove the three cable lugs from "A," "B," and "C" connectors.

(2) Remove four nuts, lock washers, flat washers, and screws which attach each 200-ampere receptacle and the 30-ampere receptacle. Lift the three receptacles from receptacle support panel and bracket.

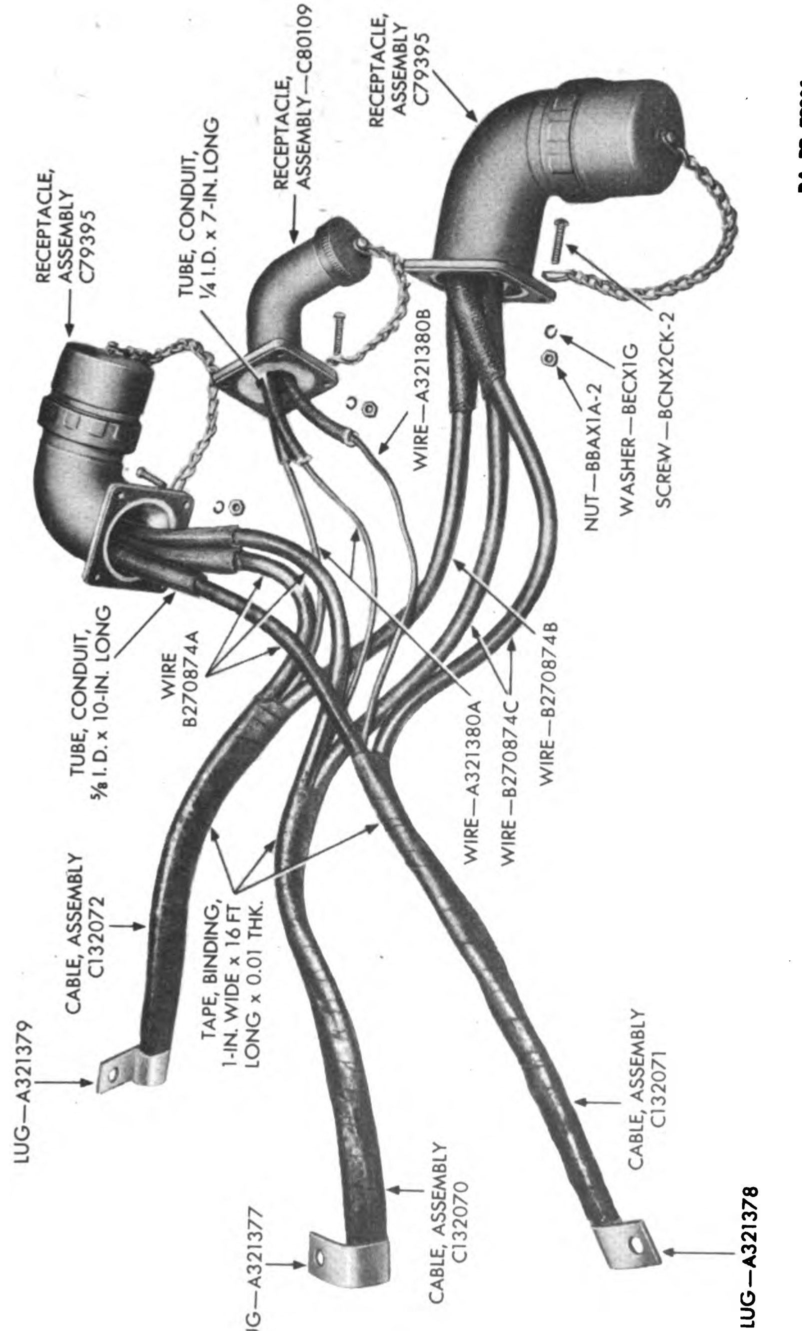


Figure 179—Receptacles and Cables Removed From Unit

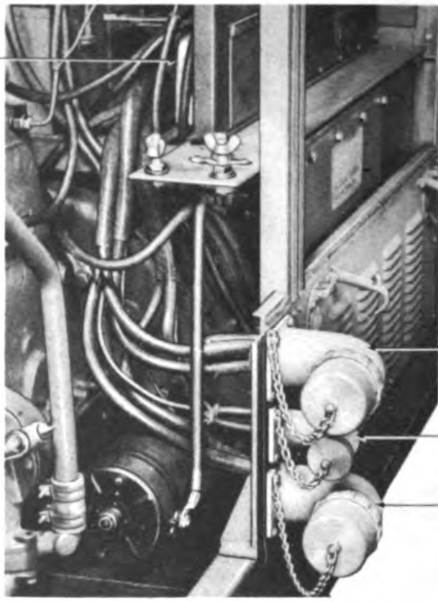


Figure 180—Power Receptacles Installed

c. **Disassembly** (fig. 181).

(1) Remove gasket from bottom of body flange.

(2) Unscrew round nut from cover and lift cover from body.

(3) Pull pin which attaches chain to cover and remove chain from cover.

(4) Remove the four screws which attach the four shoes to inside of round nut. Slip round nut from body.

(5) Remove molded rubber cover gasket from body.

(6) Remove split ring which secures insulation within body. Pull insulation from body.

(7) If necessary to repair terminal wires or insulating plate, unsolder terminals from cable wires, and remove terminals and plate from wires.

d. **Inspection and Repair.**

(1) Clean all metal parts in dry-cleaning solvent and dry with cloth. Clean insulation with a wire brush. Examine body, cover, chain, and nut for cracks. Weld or replace if cracked.

A-C GENERATING SYSTEM

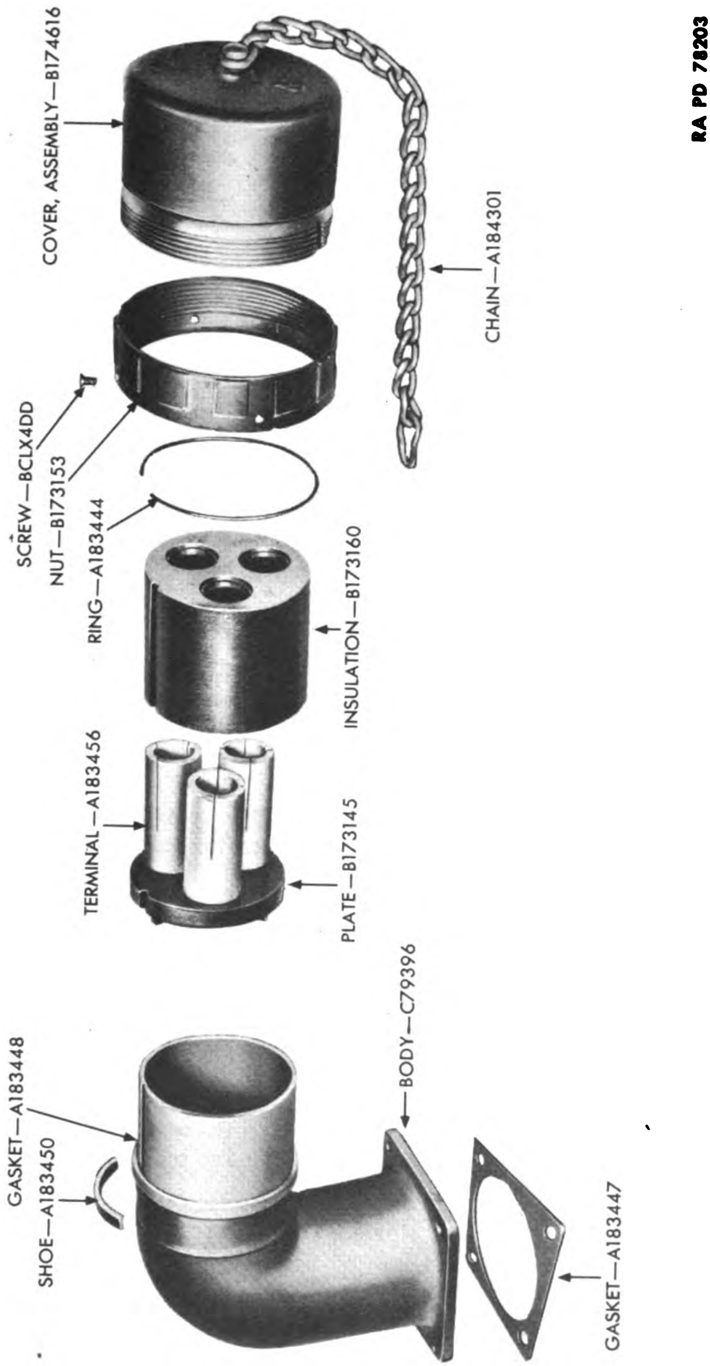


Figure 181—200-ampere Receptacle Disassembled

(2) Examine all threads to see if stripped or burred. File off all burs. Replace receptacle if unrepairable.

e. **Assembly** (fig. 181).

(1) Position cables through body gasket and body. Slide plate onto cables so that cables "A," "B," and "C" project in clockwise rotation. Cable "A" directly to left of alining groove on circumference of plate. Solder terminal to end of each cable.

(2) Slide insulation over terminals. Be sure terminals on cables "A," "B," and "C" are inserted into corresponding holes of insulation. Work wires, plate, terminals, and insulation back into position in body. Install split ring which secures insulation within body.

(3) Position round nut on body. Slide shoe into position within nut. Install screw which holds shoe to nut. Similarly install three remaining shoes.

(4) Work cover gasket into position on body.

(5) Position chain on cover and drive in pin which attaches chain to cover. Peen pin. Position cover on body and screw round nut onto cover fingertight.

f. **Installation** (fig. 180).

(1) Insert cables through hole in receptacle support panel and bracket. Place the two 200-ampere and one 30-ampere receptacles in position on receptacle support panel and bracket. Install the four plain washers, screws, lock washers, and nuts which attach each receptacle.

(2) Connect cable "A" to terminal "A" on rear of load terminal box with external tooth lock washer and nut. Similarly connect cable "B" to terminal "B" and cable "C" to terminal "C."

89. 30-AMPERE POWER RECEPTACLE.

a. **Description** (figs. 179 and 180). The 30-ampere power receptacle has a body of elbow type steel construction. Attaching end of receptacle body has a square-shaped flange with four screw holes. On the other end is a threaded edge which attaches a chained cover. The three terminals are secured in an insulating retainer which is housed within body. The assembly is held in the body by a split ring.

b. **Removal.** See paragraph 88 b.

c. **Disassembly** (fig. 182).

(1) Remove gasket from bottom of body flange and screw cover from body.

(2) Remove split ring which holds retainer within body. Force retainer terminals and insulator clear of body.

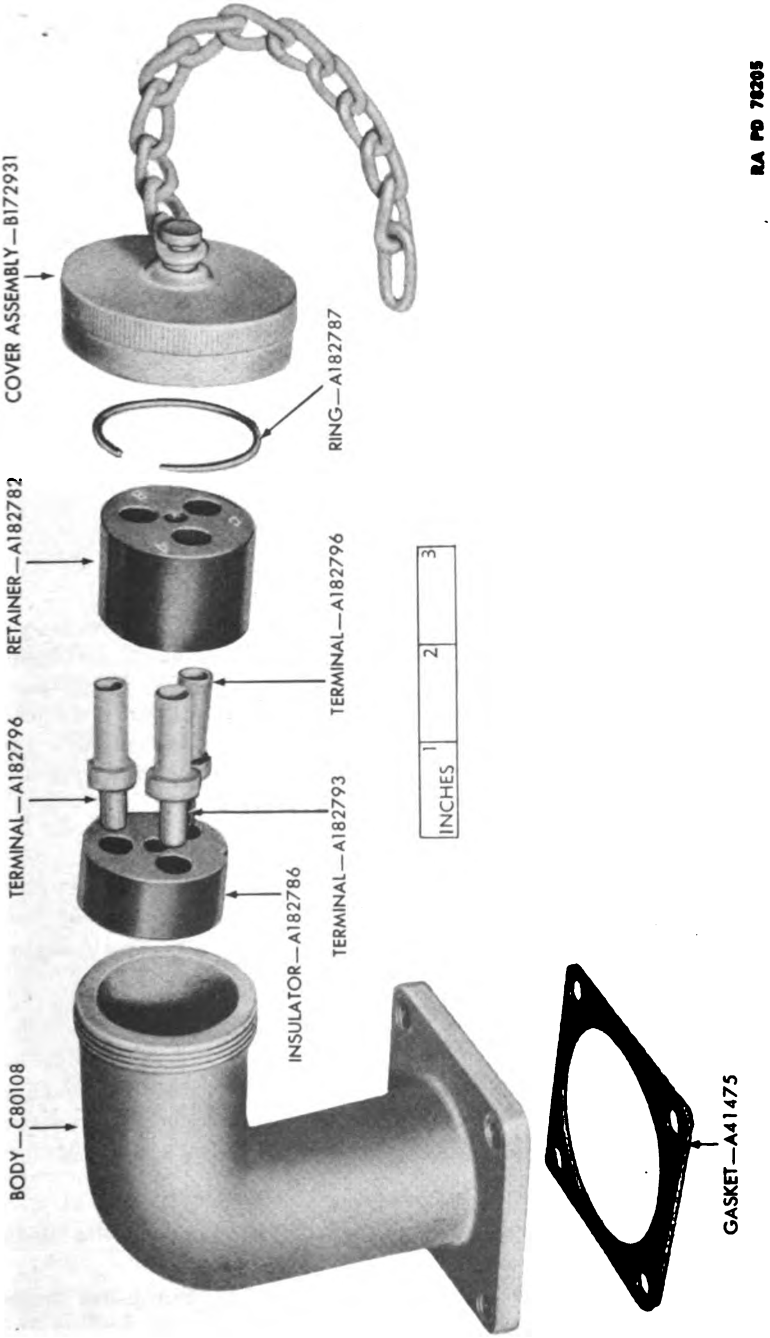


Figure 182—30-ampere Receptacle Disassembled

(3) If necessary to replace terminals, insulator, or wires, unsolder terminals from cable wires, and remove terminals and plate.

(4) Pull pin which attaches chain to cover.

d. **Inspection and Repair.** See paragraph 88 d.

e. **Assembly** (fig. 182).

(1) Insert cables into position through body gasket, body, and insulator. Be sure to set wires "A," "B," and "C" in clockwise rotation through insulator. Solder terminal to end of each wire.

(2) Position terminal of wire "A" through hole marked "A" of retainer, wire "B" through hole "B," and wire "C" through hole "C." Work wires, insulator, terminals, and retainer back into body. Install split ring which holds retainer within body.

(3) Position chain on cap, and install and peen pin which holds chain to cap. Screw cap onto body.

f. **Installation.** See paragraph 88 f.

90. LOAD TERMINAL BOX.

a. **Description** (fig. 183). The load terminal box is of rectangular-shaped sheet metal construction. Located at the lower left-hand corner of the instrument panel, it houses four connectors. Its purpose is to make possible use of the unit to operate equipment without proper sockets to fit the power receptacles. It also enables the operator to reach "O" circuit. The interior of the box is readily accessible through a door on the instrument panel.

b. **Removal** (fig. 183).

(1) From each terminal on rear of load terminal box, remove nut, external tooth lock washer, cable lug, bus bar lug, and bus bar.

(2) Remove the four screws which attach lid to box on front of instrument panel. Lift lid from panel.

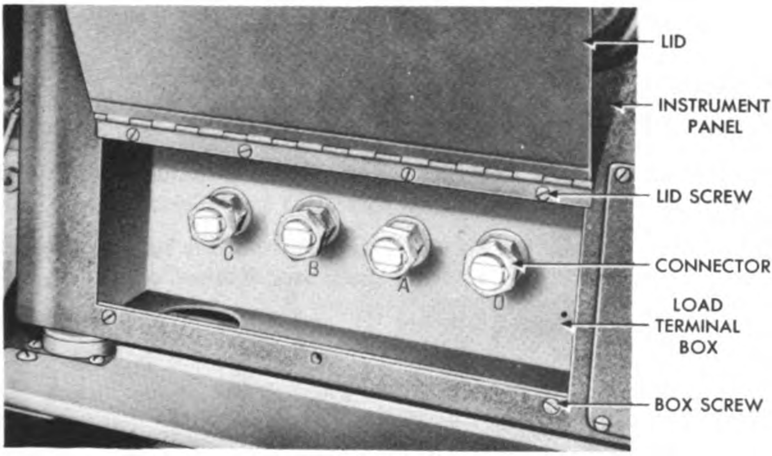
(3) Remove the five nuts, washers, and screws which attach box to instrument panel. Lift box from panel.

c. **Disassembly** (fig. 184). Remove nut, flat washer, and washer insulator from rear of each connector. Pull the four connectors from box. Remove insulating bushing and insulator from each connector.

d. **Inspection and Repair.**

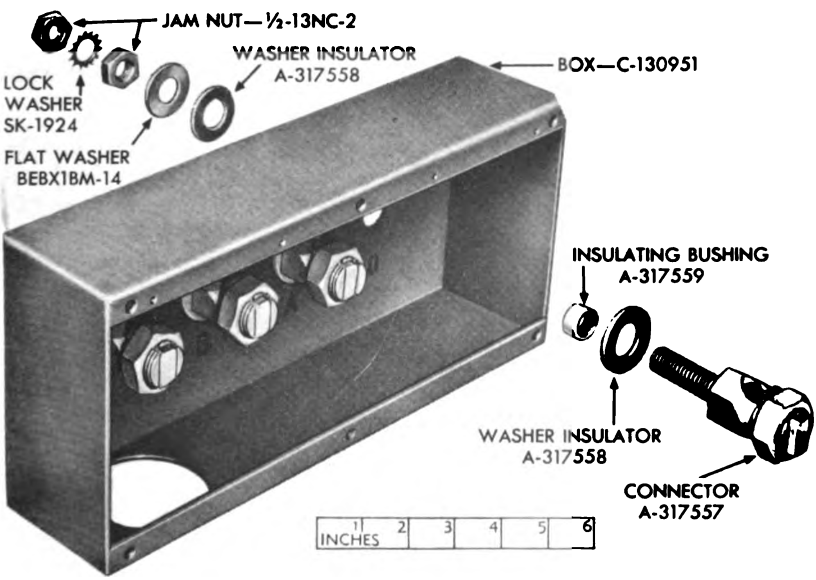
(1) Wash metal parts with dry-cleaning solvent and dry with cloth.

(2) Examine sheet metal for dents and cracks. Bump out dents and weld cracks, if possible.



RA PD 78512

Figure 183—Load Terminal Box Installed



RA PD 86677

Figure 184—Load Terminal Box Disassembled

(3) Examine fiber bushings and washers to see if any are broken or grease soaked.

(4) Inspect all connectors, screws, nuts, and metal washers to see if any are burred, bent, or broken. Examine threads of threaded parts. File off all burs.

e. **Assembly** (fig. 184).

(1) Slide washer insulator and insulating bushing onto each connector and place connectors in position in box. On back of each connector, install washer, insulator, flat washer, and nut.

(2) Position upper half of hinge on door. Drive hinge pin through hinge. Screw knurled head screw (handle) into door.

(3) On terminal "A" on rear of box, install bus bar "A," bus bar lug, receptacle cable "A," external tooth lock washer, and nut.

(4) Similarly connect bus bar "B" and cable "B" to terminal "B," and bus bar "C" and cable "C" to terminal "C."

(5) On terminal "O," install bus bar "O," external tooth lock washer, and nut.

f. **Installation** (fig. 183).

(1) Position box on instrument panel. Install the five screws, washers, and nuts which secure box to panel.

(2) Position lid on instrument panel in front of box. Install the four screws which attach lid to panel.

(3) Slide "A" bus bar onto "A" terminal on rear of box and install bus bar lug, "A" cable lug, external tooth lock washer, and nut. Similarly connect terminals "B," "C," and "O" (no bus bar on "O" terminal).

CHAPTER 6

INSTRUMENT PANEL

Section I

PANEL

91. DESCRIPTION AND CONSTRUCTION (figs. 186 and 187).

a. The panel is attached to horizontal supports welded to left side center and rear upright frames by means of rubber padded mountings.

b. Except for the fuel gage and starting motor switch, the panel brings together all controls and gages necessary for normal operation and control of the unit.

92. REMOVAL (fig. 185).

a. Remove all four doors, hood, and left rear side panel. For convenience, tool box and battery boxes may be removed.

b. Disconnect a-c generator lead wires "A," "B," and "C" from corresponding terminals of circuit breaker panel.

c. Disconnect a-c generator lead wire "O" from "O" terminal of load terminal box.

d. Disconnect a-c generator lead wires "3," "4," "8," "2A," "2B," "2C," "A2," "A1," and "F" from corresponding terminals of large terminal block.

e. Disconnect power receptacle lead wires "A," "B," and "C" from corresponding terminals of load terminal box.

f. From small terminal block, disconnect "CG" wire (to two-charge regulator), "IGN" wire (to ignition coil), "63" wire (to electric brake receptacle), "61" wire (to battery).

g. Disconnect "B+" wire to starter switch from "B+" terminal of the battery charging ammeter.

h. Disconnect oil pressure gage line from gage.

i. Unscrew nut and remove temperature gage bulb from left rear corner of engine cylinder head.

j. Disconnect throttle and choke control wires from carburetor. Pull wires free of guide bracket welded to front battery box. CAUTION: *Do not allow wires to come in contact with battery terminals.*

k. Remove screw, lock washer, and large plain washer from each of the four mountings. Lift panel from unit.

93. DISASSEMBLY (figs. 186 and 187).

a. Remove following assemblies in accordance with instructions in TM 9-617: battery charging ammeter, oil pressure gage, temperature gage, running time meter, frequency meter, voltmeter, 125-

A—MOUNTING SCREW
B—CIRCUIT BREAKER PANEL
C—LARGE TERMINAL BLOCK
D—OIL PRESSURE GAGE
E—BATTERY CHARGING AMMETER
F—ENGINE TEMPERATURE GAGE
G—THROTTLE CONTROL
H—SMALL TERMINAL BLOCK
J—LOAD TERMINAL BOX
K—CHOKE CONTROL

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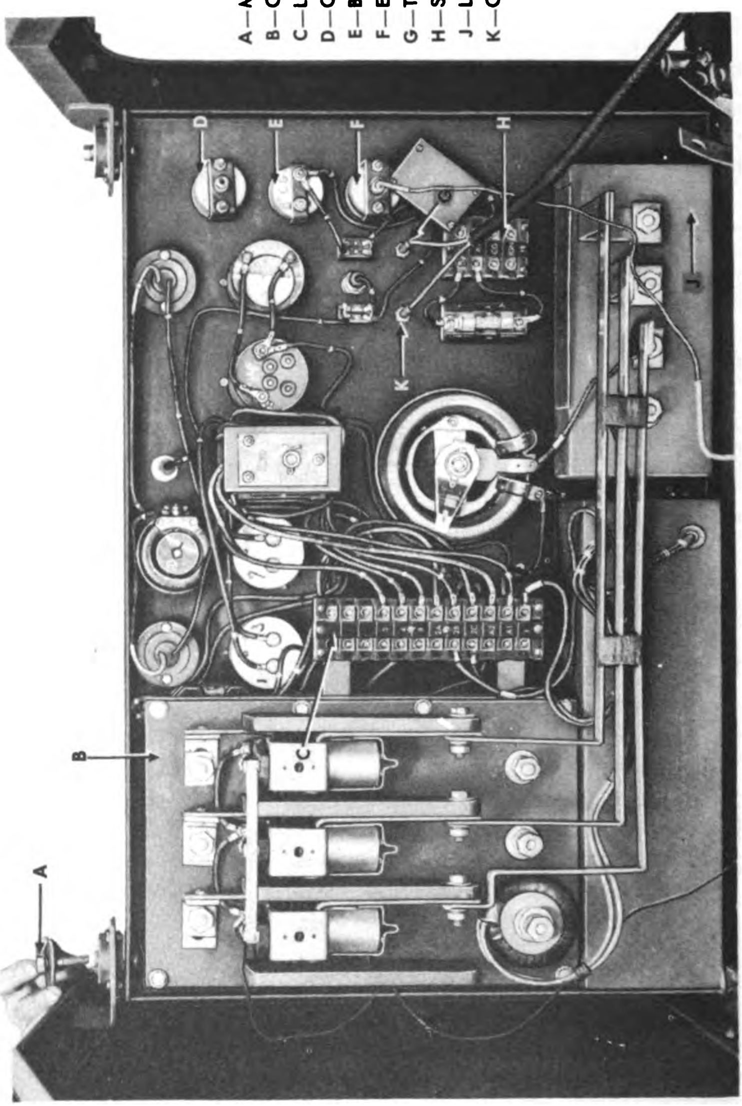


Figure 185—Instrument Panel Removal

volt ammeter, field rheostat, ignition switch, 125-volt light receptacles, 125-volt light switch, lamp-dimming rheostat, 6-volt light receptacle, 6-volt lightswitch, 6-volt receptacle, throttle control, choke control, and T-slot receptacles.

b. Remove meter switch (par. 104 **b**), circuit breaker panel assembly (par. 108 **b**), voltage regulator (par. 116), and load terminal box (par. 90 **b**).

c. Remove the two nuts and lock washers which secure small terminal block to panel. Remove the two nuts, lock washers, and screws which secure fuse block to panel. Lift terminal block and fuse block from panel.

d. Remove the screws which attach the 10 name and instruction plates to front of panel. Lift plates from panel.

94. INSPECTION AND REPAIR.

a. Inspection. Examine panel to see if it is bent or broken. See if welds have pulled loose.

b. Repair. Straighten panel if bent. Weld broken places and loosened welds. File places smooth after welding.

95. ASSEMBLY (figs. 186 and 187).

a. Position name and instruction plates on front of panel as shown in figure 205. Install screws which hold plates to panel.

b. Place small terminal block and attached fuse block in position on rear of instrument panel at lower front corner. Install the two screws, lock washers, and nuts which attach each block to panel.

c. Install load terminal box (par. 90 **f**), voltage regulator (par. 120), circuit breaker panel assembly (par. 108 **f**), and meter switch (par. 104 **f**).

d. Install following assemblies in accordance with TM 9-617: T-slot receptacles, choke control, throttle control, 6-volt receptacle, 6-volt light switch, 6-volt light receptacle, lamp-dimming rheostat, 125-volt light switch, 125-volt light receptacles, ignition switch, field rheostat, 125-volt ammeter, voltmeter, frequency meter, running time meter, temperature gage, oil pressure gage, and 12-volt ammeter.

96. INSTALLATION (fig. 185).

a. Lift panel into position on unit. Aline screw holes in mountings with screw holes in panel. Install large plain washer, lock washer, and screw which secures panel to each of the four mountings.

b. Thread throttle and choke control wires through guide bracket welded to front battery box. Connect throttle control to throttle lever on carburetor (control in, throttle open). Connect choke control to air shutter lever on carburetor (control in, shutter open).

s. Insta
(1) Usi
on left side
(2) Inst
water pump
(3) Tap
pump drive
press pulley
shaft. Instal
position.

t. Instal
position on it
tap adapter

73. INSTA

a. Instal
b. Positi
adapter. Tap
c. Using
cylinder bloc
hold governo
(fig. 13).
d. Instal
TM 9-617: U
charging gen
water pump,
fan and brac

74. INSTAI

a. Gener
depending up
generator ass
stalled by itse
b. Engin
(1) Hoist
(2) Attac
(3) Insta
front engine
engine.
(4) Conn
(fig. 12).

armature sleeve
facture. Pull arn
(4) Melt sol
rings (one wire o
off any insulating
move two diagon
Using these screw
from sleeve. Rem
insulating rings, a

h. Disassemb
(1) Remove
tach generator ter
Remove, in order
flat washer from
from terminal bol
wires connected to
assembly easier. F
terminal bolt. Pu
Remove the four c
plates. Lift termi
terminal plate. Sli
copper links from
washers, two bolts
two mounting plat
base plate.
(2) Remove s
and pull metering
ing. Slide metering
wires and from "C
wires marked "A,"
(3) Pick the t
rear end of housing

83. INSPECTION

a. Cleaning. B
metal parts with dr
Do not get solvent
b. General.
(1) Inspect all
condition of threads
if they are obstruct
(2) Check conc
bent, broken, or bur

Figure

Figure

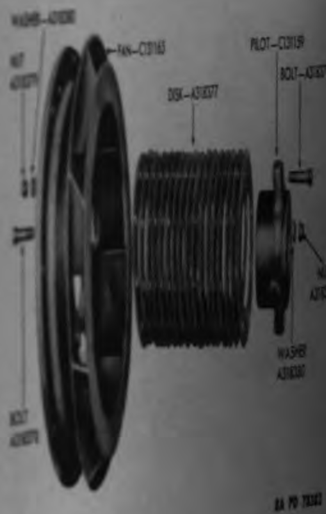


Figure 171—Front Fan Disassembled

over stator lead wires "C" and "2C." Insert generator lead wires "A," "B," "C," and "O" into position through wire exit hole in housing. Work metering current transformer wires out through wire exit hole in housing.

(3) Place a mounting plate in position on end of generator terminal box base plate. Install the eight flat washers, two bolts, two lock washers, and two nuts which secure the plates together. Similarly install remaining mounting plate on other end of terminal base plate. Position the two U-shaped copper links on rear of plate so they connect the three "O" terminal bolts. Insert "O" terminal bolts through holes in copper links and through "O" holes of plate. Slide a flat washer onto all remaining terminal bolts. Insert remaining terminal bolts into terminal bolt holes from rear of plate. Position plate within housing. Work lug of stator lead wire "2A" onto "2A" terminal bolt and install flat washer, lock washer, and nut. Similarly connect stator lead wires "1A," "2B," "1B," "2C," "1C," and "O" to their respective terminal bolts. Similarly connect generator lead wires "A," "B," "O," and "C" to their respective terminal bolts. Force terminal plate back into position within housing. Install the four lock washers and cap screws which attach terminal plate to housing. Shim all terminal bolts with flat washers as necessary to provide an even backing for terminal designation plate. Slide designation plate onto terminal bolts. Install flat washer, lock washer, and nut on each terminal bolt. Connect links with lock washers and nuts. Position of links is governed by output voltage desired (par. 87 a and b). Position terminal box

lock washers and cap screws

ling compound composed of a
varnish.

fig. 169).

s as follows (fig. 170): Position
ace separator between slip rings.
s. Install the six screws which
ssembly onto exciter armature
wire to each slip ring.

r shaft. Aline keyways of shaft
nature onto shaft. Connect each
lead with stove bolt and nut.
s with glyptal synthetic paint.
mp to shaft sleeve with clamp

t end of rotor shaft. Heat flexi-
ft over key.

of shaft. Be sure to install bear-
er are to rear.

1).

which make up flexible coupling

s, and special nuts which attach

sembly.

sition bushing A204005, lever
A204003.

in holder B178783, and install

emaining holders.

sed, tap threads in brush lead
ch self-tapping screw.

KETS.

ition bushing A204005, arm
A204003.

n holder B178779, and install

e, to assemble the remaining

RA PD 78574

handholes on
screws which

nerator. Install
erator.

l housing and

x shelf, instru-
ear side panels,

. 178).

s which attach
housing. Lift

erminal bolts.
2A," "O" and
"O" and "1C."
s.

c. Insert temperature gage bulb into fitting at left rear corner of cylinder head. Tighten nut onto fitting.

d. Connect oil pressure gage line to gage.

e. Connect "B+" wire from starter switch to "B+" terminal of battery charging ammeter.

f. To corresponding terminals of small terminal block, connect "61" wire from battery, "63" wire from electric brake receptacle, "IGN" wire from ignition coil, and "CG" wire from two-charge regulator.

g. To corresponding terminals on load terminal box, connect power receptacle lead wires "A," "B," and "C."

h. To corresponding terminals of large terminal block, connect a-c generator lead wires "F," "A1," "A2," "2C," "2B," "2A," "8," "4," and "3."

i. Connect a-c generator lead wire "O" to "O" terminal on load terminal box.

j. Connect a-c generator lead wires "A," "B," and "C" to corresponding terminals of circuit breaker.

k. Install left rear side panel, hood, and all four doors.

Section II

INSTRUMENTS AND GAGES

97. OIL PRESSURE GAGE.

a. **Description** (figs. 186 and 187). The oil pressure gage registers pressure at which oil pump is forcing oil through the engine. A copper tube connects the gage with the engine oil system. The mechanism of the instrument consists of a flattened crescent-shaped tube. As the pressure inside the tube increases, the tube straightens out. This motion is conducted to an indicator hand by linkage. Range of the gage is from zero to 50 pounds per square inch.

b. **Inspection and Repair.** Test operation by connecting gage with a tee to an accurate test gage and a source of pressure (liquid or gas). Vary pressure from zero to 50 pounds and note readings of both gages. If service gage readings vary from test gage readings, replace service gage.

98. BATTERY CHARGING AMMETER.

a. Description (figs. 186 and 187). This automotive type ammeter registers the rate of charge or discharge of the battery charging circuit. The instrument consists of a coil which sets up a magnetic field when current flows through it. This magnetism attracts or repels (depending on direction of current flow) a piece of iron. The iron is linked to a hand which indicates current flow in amperes. The ammeter reading range is from —30 amperes to +30 amperes.

b. Inspection and Repair. Connect lead wires from 6-volt dry-cell battery to posts of ammeter and note reading. Reverse leads and note reading. Repeat procedure with an accurate test ammeter. If readings of generating unit ammeter vary from test ammeter, replace the ammeter.

99. ENGINE TEMPERATURE GAGE.

a. Description (figs. 186 and 187). The mechanism of the temperature gage consists of a flattened crescent-shaped tube connected by linkage to the indicator hand. A flexible metal tube connects the crescent to a bulb which is held in the water jacket of the engine cylinder head by means of a fitting and nut. As engine temperature increases, fluid within the bulb is converted to gas. This gas exerts pressure on the inside of the crescent and causes it to straighten out. This motion is transmitted through the linkage to the indicator hand.

b. Inspection and Repair. Place bulb of gage and an accurate test thermometer in a pan of water. Heat water and compare readings of gage and an accurate thermometer at various temperatures. Replace gage if more than 2 degrees inaccurate at operating range (160°F to 190°F) or in danger range (190°F to 212°F).

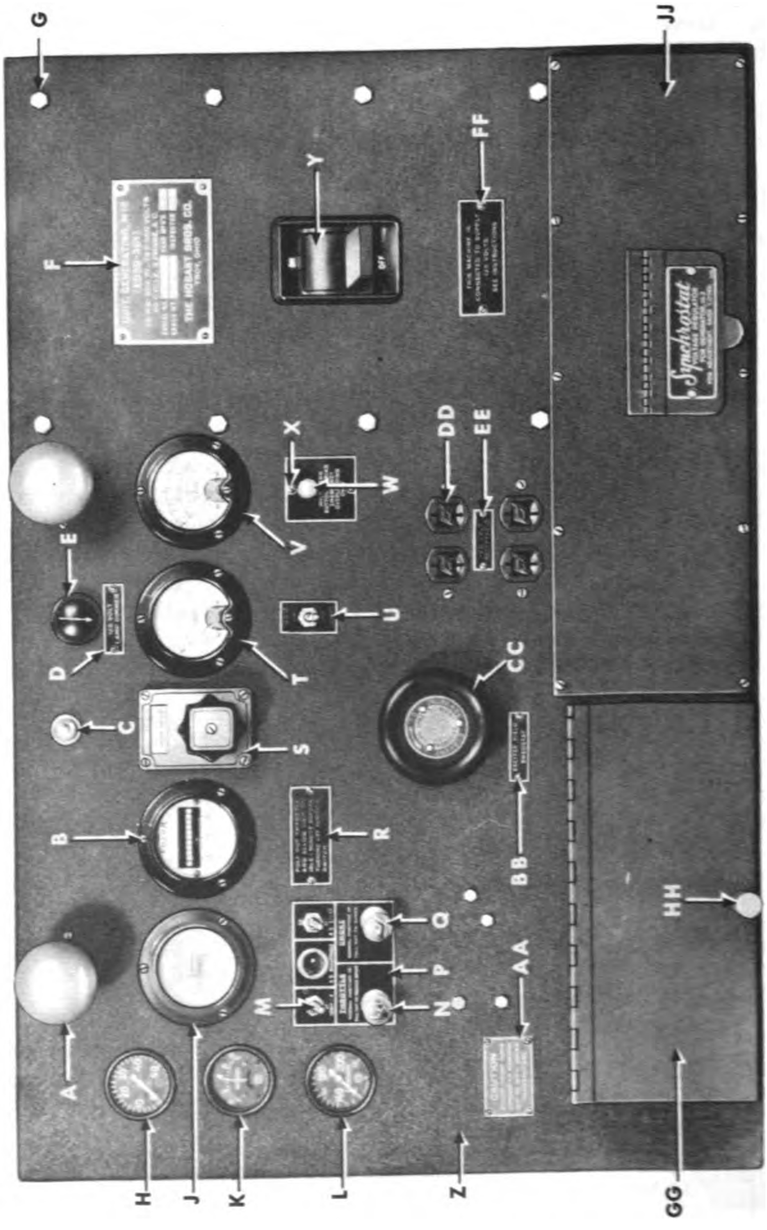
100. RUNNING TIME METER.

a. Description (figs. 186 and 187). The running time meter is an electric clock. It registers total number of hours and tenths of hours the a-c generator has been in operation.

b. Inspection and Repair. Connect meter and an accurate test clock in parallel to a source of 60-cycle current. Compare elapsed time of operation registered by meter and clock. Replace meter if there is any variation from the clock.

101. FREQUENCY METER.

a. Description (figs. 186 and 187). The frequency meter registers cycles of alternating current generated. The mechanism consists



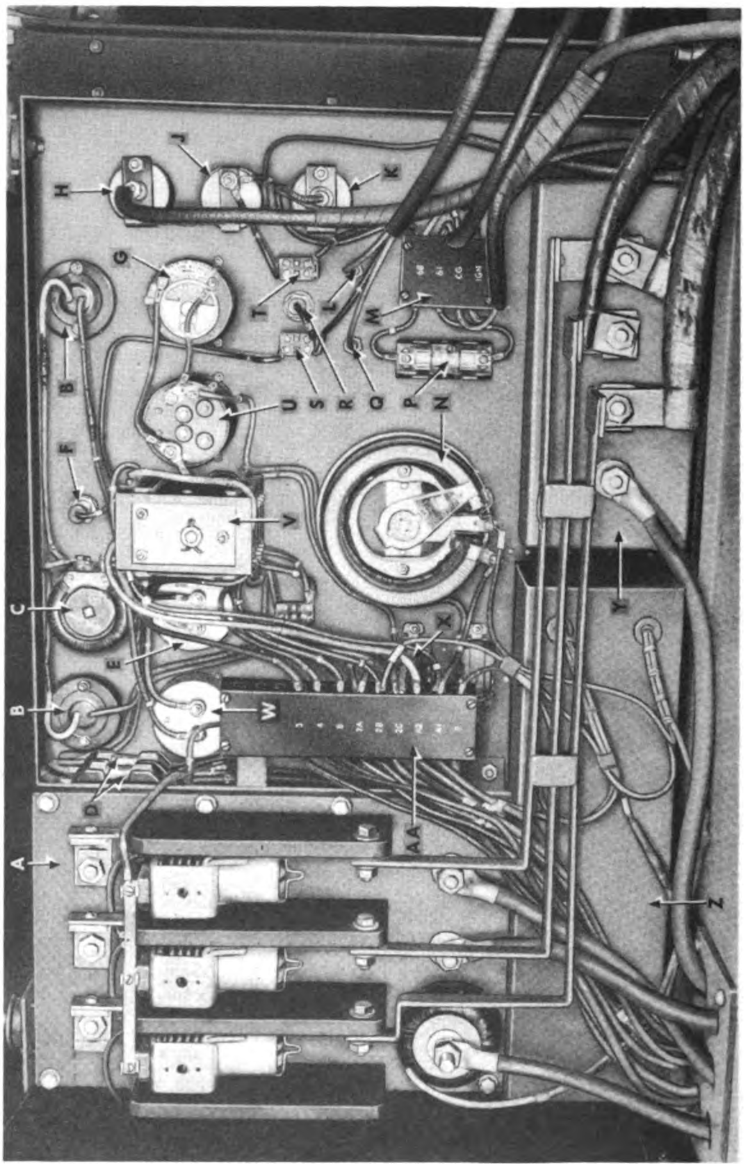
RA PD 78389

Figure 186—Instrument Panel—Front View

A—LAMP—GE-50A/RS-A19
B—METER—C130986
C—LAMP—DLAX1F
  SOCKET—A319018
D—PLATE—A202346
E—RHEOSTAT, ASSEMBLY—B181133
F—PLATE—B181640
G—SCREW—BCAX1BB-2
  NUT—BBJX1C-2
  WASHER—BECX1H
H—GAGE, ASSEMBLY—A202355
J—METER—B181163
K—AMMETER, ASSEMBLY—A202354
L—GAGE, ASSEMBLY—B175949
M—SWITCH—A319015
N—CONTROL—B181175
P—PLATE—B181190
Q—CONTROL—B181174
R—PLATE—A202353
S—SWITCH, ASSEMBLY—C130968
T—VOLTMETER—B181161
U—PLATE—A202351
V—AMMETER—B181162
W—SWITCH—A320785
X—PLATE—A320786
Y—PANEL, ASSEMBLY—D84172
Z—PANEL—D83232
AA—PLATE—A202357
BB—PLATE—A320619
CC—HANDLE—HBC-AW-729
DD—RECEPTACLE—B181172
EE—PLATE—A202338
FF—PLATE—B181189
GG—LID—B181129
HH—SCREW—A320777
JJ—COVER, ASSEMBLY—C7669408

RA PD 78389A

Legend for Figure 186—Instrument Panel—Front View



RA PD 78569

Figure 187—Instrument Panel Installed—Rear View

A—CIRCUIT BREAKER PANEL
B—125-VOLT LAMP SOCKET
C—LAMP-DIMMER RHEOSTAT
D—25-AMPERE FUSES
E—VOLTMETER
F—6-VOLT LAMP SOCKET
G—FREQUENCY METER
H—OIL PRESSURE GAGE
J—BATTERY CHARGING AMMETER
K—ENGINE TEMPERATURE GAGE
L—THROTTLE CONTROL
M—SMALL TERMINAL BLOCK
N—EXCITER FIELD RHEOSTAT
P—25-AMPERE FUSE
Q—CHOKE CONTROL
R—TROUBLE LIGHT SOCKET
S—6-VOLT LAMP SWITCH
T—IGNITION SWITCH
U—RUNNING TIME METER
V—METER SWITCH
W—125-VOLT AMMETER
X—125-VOLT T-SLOT RECEPTACLE
Y—LOAD TERMINAL BOX
Z—VOLTAGE REGULATOR
AA—LARGE TERMINAL BLOCK

RA PD 78569A

Legend for Figure 187—Instrument Panel Installed—Rear View

of a number of metal reeds above an electromagnetic coil. The reeds are selected for assembly according to their periods of vibration. The reeds are then fastened in order to a base and given final adjustment by hand. The coil is connected to one phase of the generator circuit. Thus, it produces an intermittent magnetic field. Since each reed will vibrate appreciably with only one frequency, the reed having the same frequency as the current alternations will vibrate more vigorously than the other reeds. A scale beneath the reeds shows their value in cycles. At 60 cycles, the proper frequency with engine speed of 1,200 revolutions per minute, the reed above "60" mark on scale shows maximum vibration while adjacent reeds vibrate to a lesser degree. Range is from 57 to 63 cycles.

b. Inspection and Repair. Connect meter in parallel with an accurate test meter to a source of variable alternating current. Vary engine speed to obtain 57- to 63-cycle current and observe readings of both meters. Replace meter if its readings are different from readings of test meter.

102. VOLTMETER.

a. Description (figs. 186 and 187). A conventional type combination alternating-current and direct-current voltmeter is used. It measures voltage by means of an electromagnetic coil, iron armature, linkage, and indicator hand mechanism. The voltmeter is connected to the meter switch which makes it possible to read voltage of any of the three phases as well as exciter voltage. Range of the red figures is from zero to 300 volts, black figures from zero to 150 volts.

b. Inspection and Repair.

(1) Adjust hand to zero (no load) by turning adjusting screw on face of instrument below window.

(2) Connect voltmeter in parallel with an accurate test voltmeter to a source of variable alternating current. Vary current and note readings. If service voltmeter fails to give within 2 percent of the reading of test voltmeter, replace service voltmeter.

103. POWER AMMETER.

a. Description (figs. 186 and 187). An alternating-current ammeter is provided to measure amperage of the three phases. Its mechanism consists of an electromagnetic coil, iron armature, linkage, and indicator hand assembly. Increase flow of current (amperage) increases magnetism. The armature is drawn by the magnetism and moves the hand by means of the linkage. The ammeter draws its energy from the metering current transformers located behind the generator terminal box panel in stator housing (fig. 167). This is

actually a 5-ampere ammeter, although it registers 0 to 250 amperes. The transformers cut the current down in a ratio of 250 to 5. The ammeter is connected through the metering switch which enables it to measure specific phases.

b. Tests and Adjustments (fig. 186).

(1) Adjust hand to zero (no load) by turning adjusting screw on face of ammeter below window.

(2) Connect ammeter in a circuit of a-c variable current, in series with an accurate 5-ampere test ammeter. Vary the current between 0-5 amperes and note readings on both ammeters. Replace service ammeter if its readings (black figures) fail to be just 50 times those of test ammeter at all times. NOTE: *See subparagraph* **a**, *above, for cause of divergence of readings.*

Section III

CONTROLS AND RECEPTACLES

104. METER SWITCH.

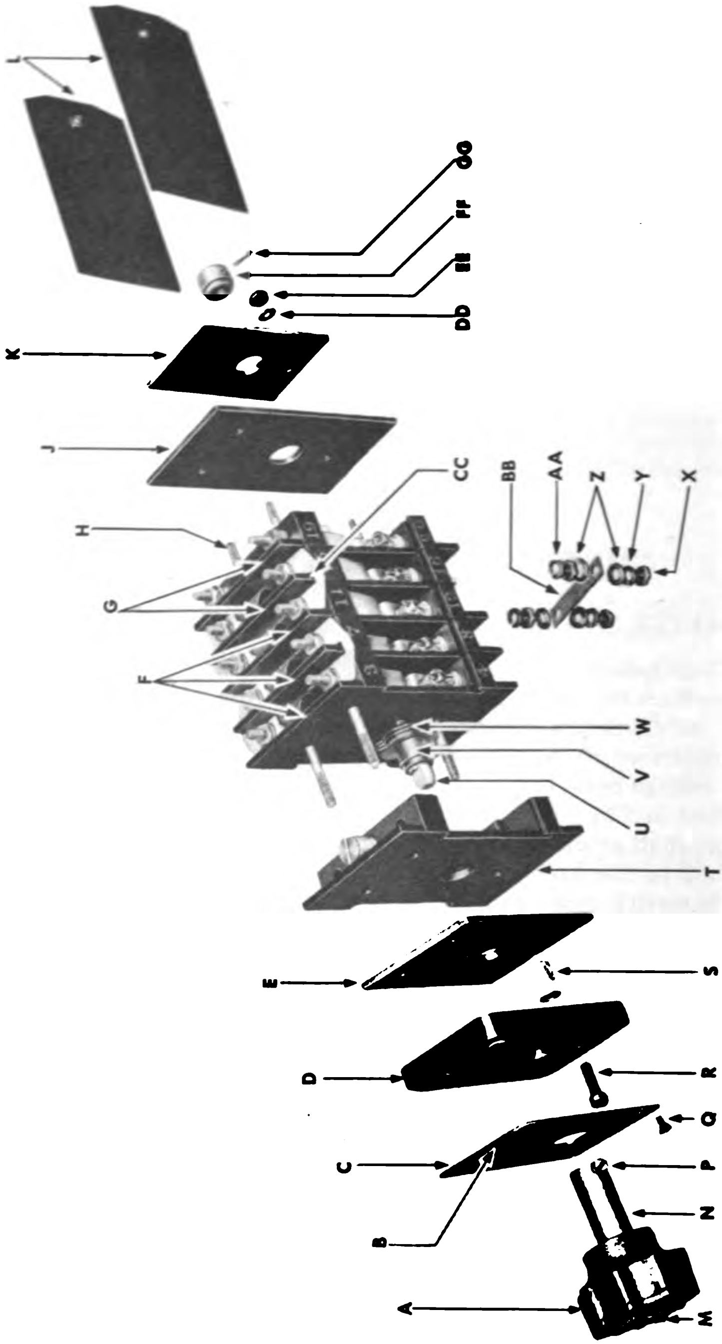
a. Description (figs. 186 and 187). A rotary type meter switch is installed on the instrument panel. Its function is to enable the operator to check the voltage of the exciter, the amperage of the current delivered to each of the three phases of the connected load, and the voltage between the phases. The method of using this switch is described in TM 9-617. The switch is housed in a bakelite case. A horizontal shaft extends the length of the switch. A knob type handle is attached to the front end of the shaft by means of a set screw. Inside the switch case, the shaft is equipped with a locater and five cams. A spring-loaded tappet presses against the locater to hold the shaft in whatever position it is set. Notches in the locater are provided for the cam to engage when the switch is set in a given position. Five contact assemblies make up the rest of the mechanism of the switch. These contacts are opened by cam action and closed by spring action.

b. Removal (figs. 186 and 187).

(1) Disconnect all wires leading to the assembly from terminals of switch.

(2) Loosen set screw which attaches handle to shaft. Pull handle from shaft.

(3) Remove the four screws which attach switch instruction plate to bakelite plate on front of instrument panel. Lift instruction plate from bakelite plate.



RA PD 46341

Figure 188—Meter Switch Disassembled

A—HANDLE—RS-16224
B—CARD—RS-49794
B—WINDOW—RS-17904
C—PLATE—RS-NP-1907
D—PLATE—RS-17915
E—PLATE—RS-17522
F—UNIT, ASSEMBLY—RS-28952
G—UNIT, ASSEMBLY—RS-28880
H—STUD—RS-29243
J—PLATE—RS-17525
K—PLATE—RS-17524
L—PANEL—RS-29251
M—PLATE—RS-NP-1654
SCREW, MACH., OVAL-HD., BR., NO. 6 (.138)-32NC-2 x ¼
N—EXTENSION—RS-17746
P—SCREW—RS-16216
Q—SCREW, MACH., OVAL-HD., BR., NO. 6 (.138)-32NC-2 x ¼
R—SCREW—BCGX1.1BG-7
S—POST—RS-17523
T—UNIT, ASSEMBLY RS-28448
U—SHAFT—RS-28970
V—BEARING—RS-17543
V—PIN—RS-26409
W—LOCATOR—RS-17738
X—NUT—A325617
Y—WASHER—BECX1E
Z—WASHER—RS-1221
AA—WASHER—BECX1E
BB—STRIP—A202339
CC—JUMPER—A202350
DD—WASHER—BECX1E
EE—NUT—BBMX1C
FF—BEARING—RS-49988
GG—PIN—BFAX1CG

RA PD 46341A

Legend for Figure 188—Meter Switch Disassembled

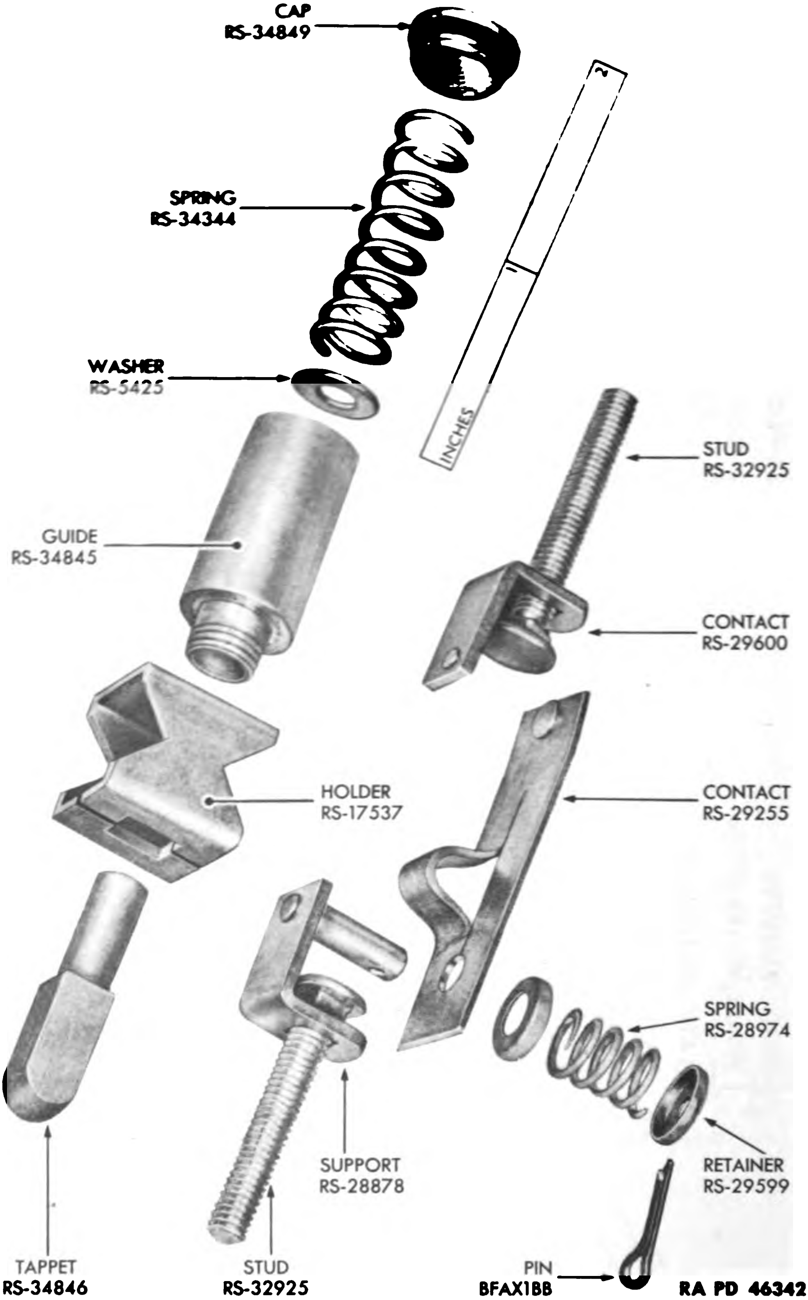


Figure 189—Meter Switch Tappet and Contacts Disassembled

(4) Remove the three screws which extend through bakelite plate, instrument panel, and posts. Lift switch from rear of instrument panel and bakelite plate from front of it.

c. **Disassembly** (fig. 188).

(1) Pull the two side panels from rear of switch.

(2) Screw the three posts from studs on front of switch. Lift plate RS-17522 and assembly unit 28448 from switch.

(3) Pull cotter pin which attaches bearing to back of shaft. Slide bearing from shaft.

(4) Remove the three nuts and lock washers which attach rear plate RS-17524 and rear plate RS-17525 to switch. Lift plates from switch.

(5) From the front three pairs of terminals on underside of switch, remove the nuts, lock washers, and plain washers which attach connecting strips. Pull strips from terminals.

d. **Inspection and Repair.**

(1) Inspect all bakelite plate panels and units which compose the frame and case of the switch. Replace broken parts.

(2) Inspect all contacts to see if they are pitted or burned. Replace contacts which are not in good condition (fig. 189).

(3) Install tappet unit RS-28448 on switch. Install handle in position on shaft, and rotate handle to its various positions. Notice tension which tappet exerts on locker.

(4) With handle installed on shaft, rotate shaft to its various positions and check effect of cam action on movable contacts. Cams should open contacts and spring action should close contacts after cams have passed by. If cams fail to open contacts, replace entire meter switch.

e. **Assembly** (fig. 188).

(1) Slide plate RS-17525 and plate RS-17524 into position on studs on rear of switch. Install the three lock washers and screws which attach plates to switch.

(2) Slide bearing RS-49988 into position on rear end of shaft. Install cotter pin through bearing and shaft.

(3) Position tappet plate assembly on the three studs on front end of switch. Be sure to seat tappet on locker. Slide plate RS-17522 into position on studs over tappet unit. Screw the three posts tightly onto studs.

(4) Slide two side panels into position in tracks on sides of switch.

(5) Between terminals 2 and 4, 5 and 8, and 10 and 12, install three strips A202339. Secure each strip on each terminal with plain washer, lock washer, and nut.

f. Installation (figs. 186 and 187).

(1) Place switch in position on back of instrument panel, screw holes in posts alined with screw holes in panel. Place plate RS-17915 in position on front of panel with its screw holes alined with screw holes in instrument panel. Install the three screws which attach plate and switch to instrument panel.

(2) Place switch name plate in position on plate RS-17915. Install the four screws which attach name plate to plate RS-17915.

(3) Slide handle into position on shaft and tighten set screw.

(4) Connect wires to switch terminals as shown in the wiring diagram (fig. 141).

105. TOGGLE SWITCHES.

a. Description (figs. 186 and 187). Three identical toggle switches are used. One controls the ignition circuit, another the 6-volt instrument panel light circuit, and the other controls the 125-volt light socket. These switches are two-pole type. However, the switches used in the ignition circuit and the 6-volt instrument panel light circuit have small metal jumpers attached across adjacent terminals to make them act as single-pole switches. The 125-volt instrument panel light is used as a two-pole switch.

b. Inspection and Repair.

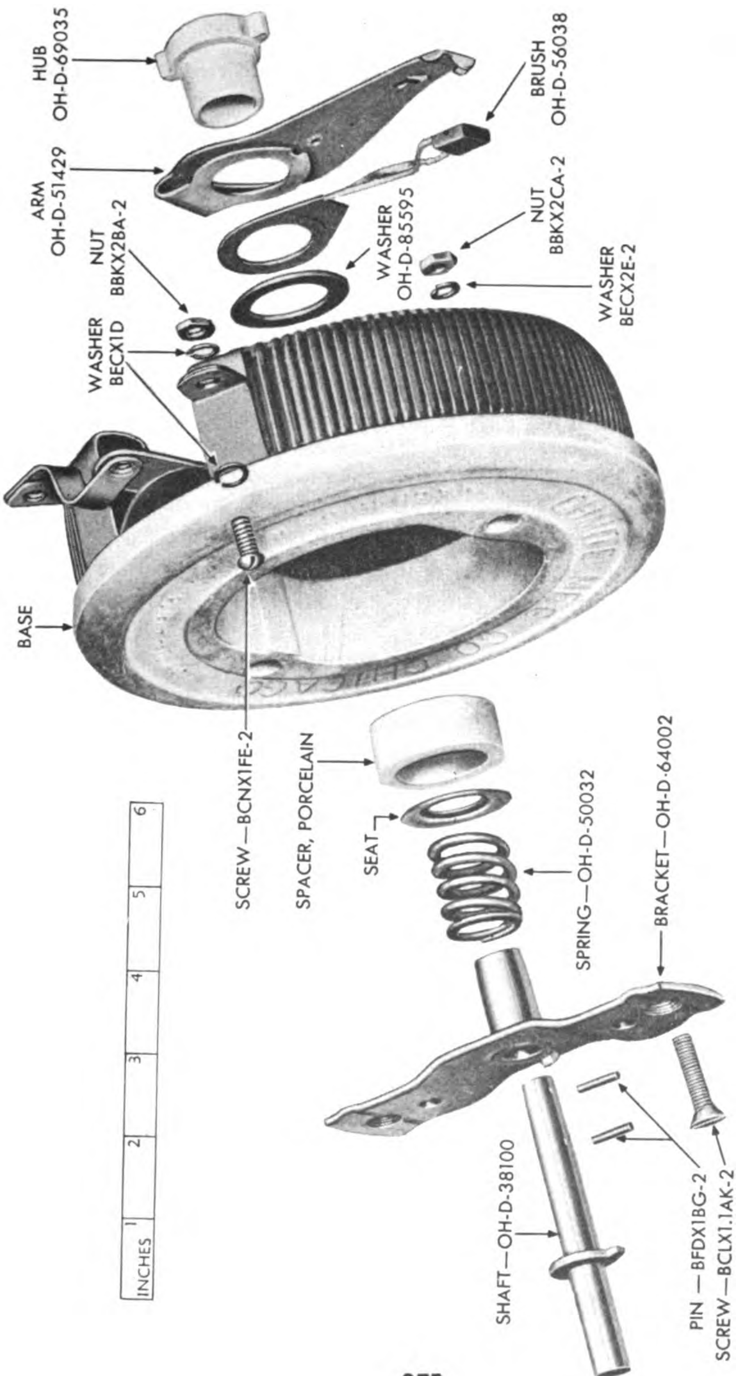
(1) Inspect composition body and switch to see if it is broken. Examine terminals to see if they are tight. Note condition of threads in terminals. Replace switch if defect is discovered.

(2) Turn switch off and test across poles with a test lamp. Replace switch if lamp lights.

(3) Turn switch on and test across poles with a test lamp. Replace switch if lamp fails to light.

106. EXCITER FIELD RHEOSTAT.

a. Description (figs. 186 and 187). The exciter field rheostat controls the output voltage of the unit when the generating unit is operated with the voltage regulator switch in "OFF" position. It works by introducing a resistance into the circuit. The instrument consists of a base upon which is wound a doughnut-shaped coil of resistant wire. A contact is mounted on a control shaft. Position of the shaft is controlled by means of a handle attached to the end of the shaft. The rheostat is rated at 75 ohms, with a maximum current flow of 3.5 amperes.



RA PD 78423

Figure 190—Exciter Field Rheostat Disassembled

b. Disassembly (fig. 190).

(1) Press down on hub on rear end of shaft and twist one-quarter turn. Pull hub and both hub pins from shaft. Lift arm, brush, and washer from shaft.

(2) Lift shaft from front of base and remove porcelain spacer, spring seat, spring, and bracket from shaft.

(3) To remove terminals, remove nut and lock washer from terminal screws and lift screws from lugs.

c. Inspection and Repair.

(1) Check base, porcelain spacer, and hub to see if they are cracked or broken. Replace entire rheostat if base is broken.

(2) Examine terminal lugs, contact surfaces of winding and arm to see if they are corroded or dirty. If necessary clean with class B flint paper No. 2/0. Use caution when cleaning windings. They must be rubbed very lightly. Do not use an aluminum-oxide abrasive cloth. Blow dust from all parts with compressed air.

(3) Examine brush to see if it shows noticeable signs of wear or if pig tails have come loose.

d. Assembly (fig. 190).

(1) Install bracket, spring, spring seat (dished side first), and porcelain spacer on shaft. Slide shaft into position through base. On back of shaft place washer, brush, and brush arm.

(2) Insert pins through pinholes in shaft. Press hub onto shaft over pins and turn one-quarter turn.

107. OVERLOAD SWITCH.

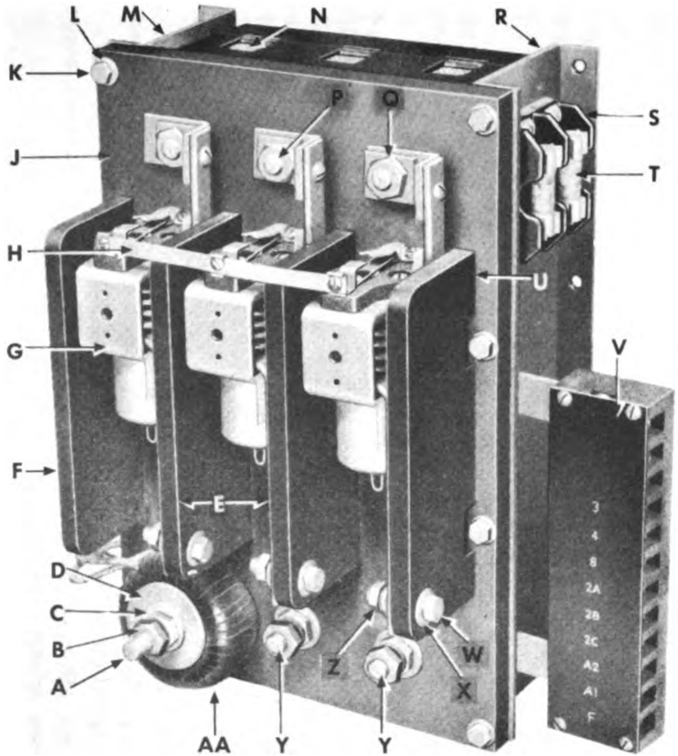
a. Description (figs. 186 and 187). A momentary contact, single-pole, push button type overload switch is installed in a circuit breaker panel trip coil circuit. Its function is to permit the unit to deliver an overload for a short period of time without having the circuit breaker kick off.

b. Inspection and Repair.

(1) Inspect case of switch to see if it is broken. Test action of push button to see if it returns to release position. Inspect threads on terminals and terminal screws.

(2) With button released, place probes of test lamp on two terminals.

(3) With button depressed, place probes of test lamp upon the two terminals.



A—STUD, BR., TN-PLTD., ½-13NC-2 x 6⅜" LONG
B—NUT—BBCX1E-2
WASHER—BECX1M
C—NUT, JAM, HEX., BR., ½-13NC-2
WASHER, PLAIN, BR., TN-PLTD., ½ (9/16 I. D. x 1¼ O. D. x 3/32-IN. THK.)
D—INSULATOR—A320612
E—SEPARATOR—B181183
F—SEPARATOR—B181181
G—RELAY, ASSEMBLY—C130987
H—STRIP, COP., ⅜ WIDE x 6½ LONG x 1/32-IN. THK.)
J—PLATE—C130992
K—SCREW—BCAX1BE-2
L—WASHER—BEBX1H-2
M—CHANNEL—B181184
N—BREAKER—D84173
P—STUD—A320605
Q—PLATE—A320604
R—CHANNEL—C130996
S—BLOCK—A319017
T—FUSE, ASSEMBLY—JEC-380-025
U—SEPARATOR—B181182
V—BLOCK—C130990
W—SCREW—BCAX1CE-2
X—WASHER—BEBX1K-2
Y—STUD—A320606
Z—NUT—BBJX1C-2
AA—TRANSFORMER—B181134

RA PD 78403

Figure 191—Circuit Breaker Panel Assembly Removed

108. CIRCUIT BREAKER PANEL ASSEMBLY.

a. **Description** (figs. 186 and 187). The circuit breaker panel assembly is attached to the rear of the instrument panel adjacent to the rear edge of the panel. The entire assembly consists of a circuit breaker proper including three overload relays, a cross-current compensating transformer, and necessary mounting plates and terminal studs. A circuit breaker serves as a load switch as well as a safety shut-off device for the output of the generator. All three phases are routed through it.

b. **Removal** (figs. 186 and 187).

(1) Remove terminal block from bracket on circuit breaker channel (par. 113 b).

(2) Disconnect main generator leads "A," "B," and "C" from corresponding terminals of circuit breaker.

(3) Disconnect bus bar from upper terminals "A," "B," and "C" on circuit breaker panel.

(4) Disconnect current compensating transformer leads "R5" and "R6."

(5) Disconnect lead "2C" from overload switch and lead "2A" from fuse block terminal, and remove fuse block from channel.

(6) Remove the eight nuts, washers, and screws which attach panel channels to instrument panel.

c. **Disassembly** (fig. 191). Only partial disassembly is given here. This is an extremely delicate assembly and if repairs cannot be made without further disassembly than is given here, replace the entire assembly.

(1) Remove the eight nuts, lock washers, screws, and plain washers which attach the two channels to sides of breaker panel assembly. Lift channels from panels.

(2) From each of the three upper studs A320605 remove nut and plate. From center and right-hand terminal studs at bottom of instrument panel, remove nut, lock washer, nut, and plain washer. From left-hand terminal stud at bottom of panel, remove nut, lock washer, nut, plain washer, insulator, transformer, nut, and plain washer. Lift rear plate from circuit breaker.

(3) To remove and disassemble relays from rear panel, proceed as follows:

(*a*) Remove the three screws which attach jumper strip across top terminal with relays. Lift strip from relays.

(*b*) Remove the three nuts, lock washers, plain washers, and cap screws which make up the bus bar terminals.

(*c*) Lift relays from panel.

(d) Unhook bail from relay head and pull head from relay. Lift two spacers and coil from relay.

(e) Remove the four screws, lock washers, and flat washers which attach circuit breaker cover to front of circuit breaker. Lift cover from circuit breaker.

(f) Remove nut and plain washer from each terminal stud and remove the six studs from circuit breaker.

(g) Remove the four screws and washers which attach each of the four relay divider plates to back of rear panel. Lift plates from panel.

d. **Inspection and Repair.**

(1) Inspect cover, case, plates, and panel to see if any of them are cracked or broken.

(2) Test current compensating transformer for open circuit by placing probes of test lamp on insulated tips of transformer leads. Replace transformer if lamp fails to light.

(3) Set breaker handle at "ON" position and test for continuity of circuit from bottom terminal lug to top terminal lug of each of the three phases.

(4) Place circuit breaker handle in "OFF" position and repeat tests of step (3), above.

(5) Inspect contact points of all three overload relays.

(6) Inspect insulation of all exposed wires.

(7) Examine all connections to see if they are clean and tight.

(8) Examine all nuts, washers, studs, metal plates, and screws to see if they are bent, broken, burred, or if threaded parts have damaged threads. Remove burs with a fine mill file.

e. **Assembly** (figs. 192 and 193).

(1) Place the four relay divider panels in position on back of rear plates. Install the four washers and screws which attach each panel to plate.

(2) Install three studs A320605 in stud holes in top of circuit breaker through terminal lugs. Install flat washer and nut on each stud inside circuit breaker case. Similarly install two studs A320606 in two right-hand stud holes (facing rear of assembly) at bottom of circuit breaker case. Install long stud in same manner in left-hand hole at bottom of case. Slide a spacer onto each of the six studs.

(3) Place the two spacers in position on relay spring and slide spring into position within relay. Push head down into position on relay and hook wire bail around head. Place the three relays in position between divider strips on back of relay. Install the three

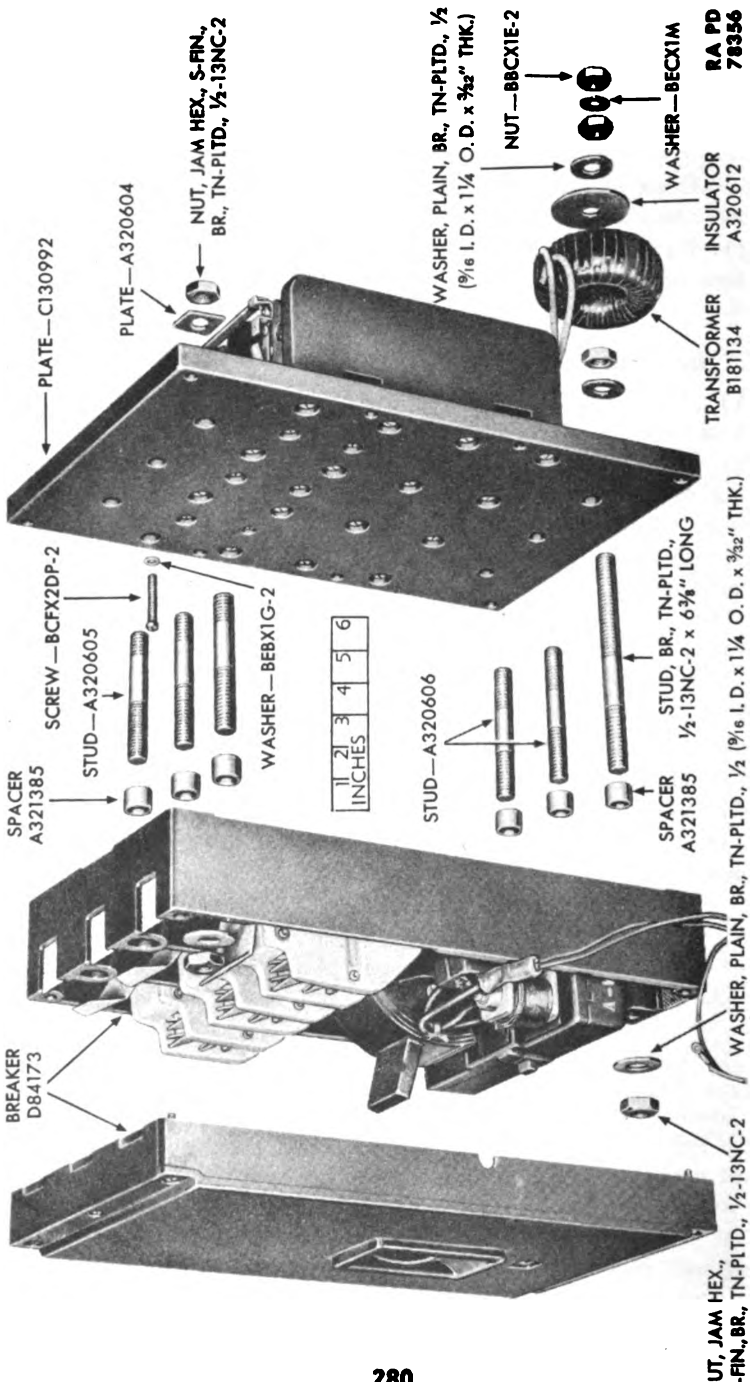


Figure 192—Circuit Breaker Panel Assembly Partially Disassembled

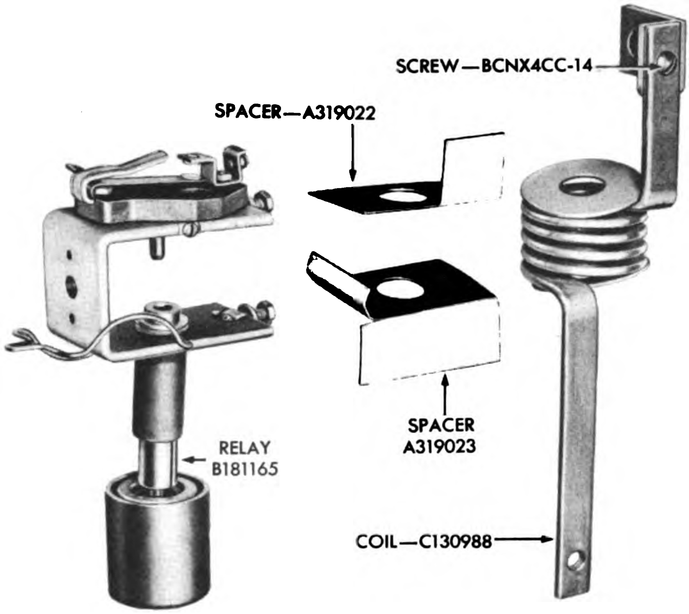


Figure 193—Circuit Breaker Relay Disassembled

cap screws, plain washers, lock washers, and nuts which make up the three bus bar terminals.

(4) Place rear plate assembly in position on studs over spacers on back of circuit breaker case. On each of the three top studs install plate A320604 and nut. On each of the two right-hand lower studs install plain washer, nut, lock washer, and second nut. On long left-hand lower stud, install plain washer, nut, current compensating transformer, insulator, plain washer, nut, lock washer, and nut.

(5) Position cover on front of circuit breaker case, and install the four plain washers, lock washers, and screws which attach cover to case.

f. Installation (figs. 186 and 187).

(1) Place circuit breaker panel assembly in position on rear of instrument panel. Aline screw holes in panel channels and instrument panel, and install the eight screws, washers, and nuts which attach channels to instrument panel.

(2) Place fuse block in position on channel, and install the two screws which attach fuse block to channel.

(3) Connect lead wire "2A" to lower right-hand fuse terminal. Connect lead "2C" to the terminal on the overload switch which has no other wire connected to it.

(4) Connect current compensating transformer leads "R5" and "R6" to the correspondingly marked leads from the voltage regulator.

(5) Connect bus bar terminals "A," "B," and "C" to the corresponding upper terminals on the circuit breaker panel.

(6) Connect main generator leads "A," "B," and "C" to the corresponding lower terminals on the circuit breaker panel.

(7) Place terminal block in position on its brackets on the right-hand channel. Install the two screws which attach terminal block to channel.

109. LAMP DIMMER RHEOSTAT.

a. **Description** (figs. 186 and 187). The lamp dimmer rheostat is similar in construction and function to the exciter field rheostat previously described (par. 106), except that it is smaller in capacity and size. It is rated at 100 watts, 200 ohms, and 0.7 ampere.

b. **Disassembly** (fig. 194).

(1) Remove screw, plate, insulator, and washer from contact base at rear of rheostat.

(2) Loosen set screw and pull knob from shaft. Pry snap washer from groove in shaft. Unscrew nut from shaft. Loosen nuts on screw at rear edge of form and unhook contact pig tail from screw. Lift entire contact and shaft assembly from rear of rheostat. Slide spring and plain washer from shaft.

(3) Remove all nuts, washers, and the one jumper strip from the three terminal screws which project from side of form.

c. **Inspection and Repair.**

(1) Check porcelain form and contact base to see if they are cracked or broken. Inspect windings, contact, pig tail, strip, and terminal screws to see if they are broken, worn, or corroded. Test windings for an open circuit, indicating a break, with a 110-volt test lamp.

(2) Remove dirt and corrosion from contact, terminal screws, and points of contact on windings, pig tail, and jumper strip with class B flint paper, No. 2/0. Rub windings lightly if at all. Blow dust from parts with compressed air.

(3) Check tightness of the two form-to-base screws. Tighten nuts if screws are loose.

d. **Assembly** (fig. 194).

(1) Place plain washer on rear and bottom terminal screws. Slide jumper onto both screws. Install lock washer, nut, second lock washer, and second nut on each of terminal screws. Leave nuts loose on rear screw until connection of contact pig tail is made.

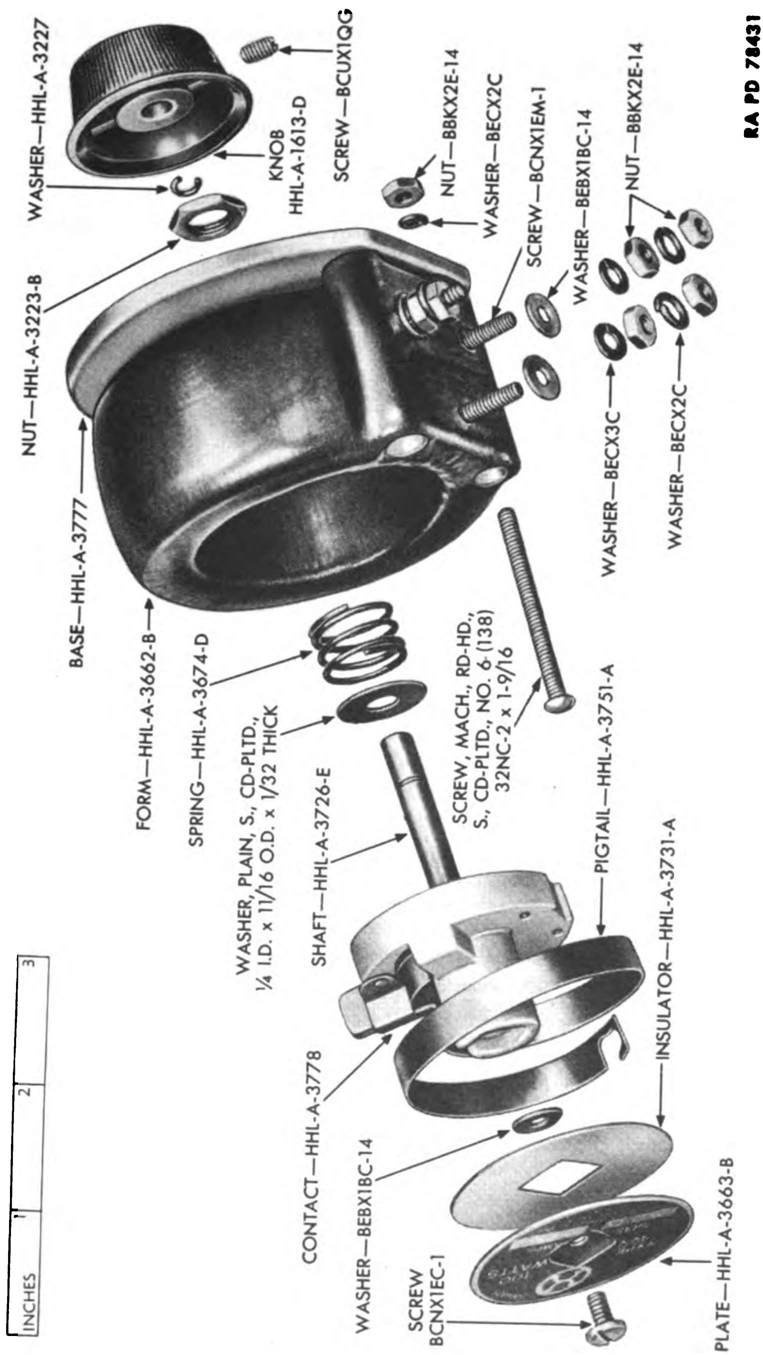


Figure 194—Lamp Dimmer Rheostat Disassembled

(2) On top terminal screw, install plain washer, lock washer, nut, second lock washer and nut.

(3) Slide flat washer and spring onto front end of shaft. Insert shaft through shaft hole in base. Slide contact pig tail under head of rear terminal screw and tighten both nuts on screw.

(4) On front of shaft, install nut, snap washer, and knob.

(5) Position washer, insulator, and plate on rear of contact base. Install the screw which secures the parts to the base.

110. 125-VOLT LAMP SOCKETS.

a. **Description** (figs. 186 and 187). The two 125-volt screw type lamp sockets at the top of the instrument panel are of soft molded rubber construction. Lead wires, which project from the backs of sockets, are soldered to metal contact and shell.

b. **Inspection and Repair.** Inspect contact and shell to see if they are bent or corroded. Inspect rubber mounting to see if it is torn. Test functioning of socket by screwing a lamp into it and applying current to the leads. If corroded, clean contacts with class B flint paper, No. 2/0. If inspection reveals any other damage to lamp socket, replace the entire assembly since it cannot be disassembled.

111. 6-VOLT LAMP AND TROUBLE LIGHT SOCKETS.

a. **Description** (figs. 186 and 187). Two identical single-contact 6-volt sockets are installed on the panel. One serves as a receptacle for the 6-volt panel lamp at the top of the panel. The other is located in the engine control group and is intended to be used as a receptacle for a 6-volt trouble light. These receptacles are standard automotive type, single-contact, threaded neck, bayonet sockets.

b. **Inspection and Repair.** Clean corrosion from contact and inside of socket with class B flint paper, No. 2/0. Inspect the assembly to see if metal parts are bent or insulating parts are broken. Test operation by inserting a lamp into socket. Apply current to lead and metal part of socket. If lamp fails to light, or if other defect is discovered upon inspection, replace the entire assembly.

112. 125-VOLT T-SLOT RECEPTACLE.

a. **Description** (figs. 186 and 187). The two duplex receptacles are of molded one-piece construction. They are similar to receptacles commonly employed in the household light circuits. The case is made of bakelite, and contacts are composed of strip copper. Each receptacle is fitted with screw type terminals on its sides. Capacity rating of the receptacles is 125 volts and 15 amperes.

b. **Inspection and Repair.** Inspect bakelite to see if it is broken. Clean corrosion from terminals and contact points with class B flint paper, No. 2/0. Test operation by connecting a source of current to terminals and inserting a plug connected to a lamp in T-slot. Normal lighting of lamp indicates satisfactory operation of receptacle. Replace receptacle if case is broken or if receptacle is inoperative.

113. TERMINAL BLOCKS.

a. **Description** (fig. 187). Two terminal blocks are mounted on the rear of the instrument panel. The smaller of the two is near the front end of the panel and is used as a junction for the engine electrical system. The larger terminal block is attached to the iron channels which mount the circuit breaker panel assembly. It serves as a junction for the alternating-current system. The smaller terminal block has four sets of terminals while the larger terminal block has 12 sets of terminals. However, only nine of the sets of terminals on the larger terminal block are used. Each of the terminal blocks consists of a bakelite base with divider strips molded between the pairs of terminals and equipped with metal inserts to receive screws. Each block is equipped with a fiber cover which attaches to the base with four screws.

b. **Removal** (fig. 187).

(1) Remove the four screws which attach terminal cover to terminal block. Lift cover from block.

(2) Disconnect all wires from terminals of terminal block.

(3) Remove the screws which attach designation strip along center of terminal block.

(4) Remove the two nuts, lock washers, and screws which attach terminal block to instrument panel (engine electrical system terminal block) or circuit breaker panel assembly channel (alternating-current system terminal block). Lift block from unit.

c. **Inspection and Repair.**

(1) Inspect terminal block cover, designation strip, and base to see if they are cracked or broken.

(2) Inspect copper strips and brass screws which make up terminals to see if they are corroded or damaged. Clean corrosion from parts with fine class B flint paper, No. 2/0. Straighten or replace bent metal parts.

(3) Inspect all screws, nuts, and lock washers to see if they are bent, broken, or have damaged threads. Remove burs with a fine mill file.

(2) On top terminal screw, install plain washer, lock washer, nut, second lock washer and nut.

(3) Slide flat washer and spring onto front end of shaft. Insert shaft through shaft hole in base. Slide contact pig tail under head of rear terminal screw and tighten both nuts on screw.

(4) On front of shaft, install nut, snap washer, and knob.

(5) Position washer, insulator, and plate on rear of contact base. Install the screw which secures the parts to the base.

110. 125-VOLT LAMP SOCKETS.

a. Description (figs. 186 and 187). The two 125-volt screw type lamp sockets at the top of the instrument panel are of soft molded rubber construction. Lead wires, which project from the backs of sockets, are soldered to metal contact and shell.

b. Inspection and Repair. Inspect contact and shell to see if they are bent or corroded. Inspect rubber mounting to see if it is torn. Test functioning of socket by screwing a lamp into it and applying current to the leads. If corroded, clean contacts with class B flint paper, No. 2/0. If inspection reveals any other damage to lamp socket, replace the entire assembly since it cannot be disassembled.

111. 6-VOLT LAMP AND TROUBLE LIGHT SOCKETS.

a. Description (figs. 186 and 187). Two identical single-contact 6-volt sockets are installed on the panel. One serves as a receptacle for the 6-volt panel lamp at the top of the panel. The other is located in the engine control group and is intended to be used as a receptacle for a 6-volt trouble light. These receptacles are standard automotive type, single-contact, threaded neck, bayonet sockets.

b. Inspection and Repair. Clean corrosion from contact and inside of socket with class B flint paper, No. 2/0. Inspect the assembly to see if metal parts are bent or insulating parts are broken. Test operation by inserting a lamp into socket. Apply current to lead and metal part of socket. If lamp fails to light, or if other defect is discovered upon inspection, replace the entire assembly.

112. 125-VOLT T-SLOT RECEPTACLE.

a. Description (figs. 186 and 187). The two duplex receptacles are of molded one-piece construction. They are similar to receptacles commonly employed in the household light circuits. The case is made of bakelite, and contacts are composed of strip copper. Each receptacle is fitted with screw type terminals on its sides. Capacity rating of the receptacles is 125 volts and 15 amperes.

b. Inspection and Repair. Inspect bakelite to see if it is broken. Clean corrosion from terminals and contact points with class B flint paper, No. 2/0. Test operation by connecting a source of current to terminals and inserting a plug connected to a lamp in T-slot. Normal lighting of lamp indicates satisfactory operation of receptacle. Replace receptacle if case is broken or if receptacle is inoperative.

113. TERMINAL BLOCKS.

a. Description (fig. 187). Two terminal blocks are mounted on the rear of the instrument panel. The smaller of the two is near the front end of the panel and is used as a junction for the engine electrical system. The larger terminal block is attached to the iron channels which mount the circuit breaker panel assembly. It serves as a junction for the alternating-current system. The smaller terminal block has four sets of terminals while the larger terminal block has 12 sets of terminals. However, only nine of the sets of terminals on the larger terminal block are used. Each of the terminal blocks consists of a bakelite base with divider strips molded between the pairs of terminals and equipped with metal inserts to receive screws. Each block is equipped with a fiber cover which attaches to the base with four screws.

b. Removal (fig. 187).

(1) Remove the four screws which attach terminal cover to terminal block. Lift cover from block.

(2) Disconnect all wires from terminals of terminal block.

(3) Remove the screws which attach designation strip along center of terminal block.

(4) Remove the two nuts, lock washers, and screws which attach terminal block to instrument panel (engine electrical system terminal block) or circuit breaker panel assembly channel (alternating-current system terminal block). Lift block from unit.

c. Inspection and Repair.

(1) Inspect terminal block cover, designation strip, and base to see if they are cracked or broken.

(2) Inspect copper strips and brass screws which make up terminals to see if they are corroded or damaged. Clean corrosion from parts with fine class B flint paper, No. 2/0. Straighten or replace bent metal parts.

(3) Inspect all screws, nuts, and lock washers to see if they are bent, broken, or have damaged threads. Remove burs with a fine mill file.

(2) On top terminal screw, install plain washer, lock washer, nut, second lock washer and nut.

(3) Slide flat washer and spring onto front end of shaft. Insert shaft through shaft hole in base. Slide contact pig tail under head of rear terminal screw and tighten both nuts on screw.

(4) On front of shaft, install nut, snap washer, and knob.

(5) Position washer, insulator, and plate on rear of contact base. Install the screw which secures the parts to the base.

110. 125-VOLT LAMP SOCKETS.

a. **Description** (figs. 186 and 187). The two 125-volt screw type lamp sockets at the top of the instrument panel are of soft molded rubber construction. Lead wires, which project from the backs of sockets, are soldered to metal contact and shell.

b. **Inspection and Repair.** Inspect contact and shell to see if they are bent or corroded. Inspect rubber mounting to see if it is torn. Test functioning of socket by screwing a lamp into it and applying current to the leads. If corroded, clean contacts with class B flint paper, No. 2/0. If inspection reveals any other damage to lamp socket, replace the entire assembly since it cannot be disassembled.

111. 6-VOLT LAMP AND TROUBLE LIGHT SOCKETS.

a. **Description** (figs. 186 and 187). Two identical single-contact 6-volt sockets are installed on the panel. One serves as a receptacle for the 6-volt panel lamp at the top of the panel. The other is located in the engine control group and is intended to be used as a receptacle for a 6-volt trouble light. These receptacles are standard automotive type, single-contact, threaded neck, bayonet sockets.

b. **Inspection and Repair.** Clean corrosion from contact and inside of socket with class B flint paper, No. 2/0. Inspect the assembly to see if metal parts are bent or insulating parts are broken. Test operation by inserting a lamp into socket. Apply current to lead and metal part of socket. If lamp fails to light, or if other defect is discovered upon inspection, replace the entire assembly.

112. 125-VOLT T-SLOT RECEPTACLE.

a. **Description** (figs. 186 and 187). The two duplex receptacles are of molded one-piece construction. They are similar to receptacles commonly employed in the household light circuits. The case is made of bakelite, and contacts are composed of strip copper. Each receptacle is fitted with screw type terminals on its sides. Capacity rating of the receptacles is 125 volts and 15 amperes.

b. Inspection and Repair. Inspect bakelite to see if it is broken. Clean corrosion from terminals and contact points with class B flint paper, No. 2/0. Test operation by connecting a source of current to terminals and inserting a plug connected to a lamp in T-slot. Normal lighting of lamp indicates satisfactory operation of receptacle. Replace receptacle if case is broken or if receptacle is inoperative.

113. TERMINAL BLOCKS.

a. Description (fig. 187). Two terminal blocks are mounted on the rear of the instrument panel. The smaller of the two is near the front end of the panel and is used as a junction for the engine electrical system. The larger terminal block is attached to the iron channels which mount the circuit breaker panel assembly. It serves as a junction for the alternating-current system. The smaller terminal block has four sets of terminals while the larger terminal block has 12 sets of terminals. However, only nine of the sets of terminals on the larger terminal block are used. Each of the terminal blocks consists of a bakelite base with divider strips molded between the pairs of terminals and equipped with metal inserts to receive screws. Each block is equipped with a fiber cover which attaches to the base with four screws.

b. Removal (fig. 187).

(1) Remove the four screws which attach terminal cover to terminal block. Lift cover from block.

(2) Disconnect all wires from terminals of terminal block.

(3) Remove the screws which attach designation strip along center of terminal block.

(4) Remove the two nuts, lock washers, and screws which attach terminal block to instrument panel (engine electrical system terminal block) or circuit breaker panel assembly channel (alternating-current system terminal block). Lift block from unit.

c. Inspection and Repair.

(1) Inspect terminal block cover, designation strip, and base to see if they are cracked or broken.

(2) Inspect copper strips and brass screws which make up terminals to see if they are corroded or damaged. Clean corrosion from parts with fine class B flint paper, No. 2/0. Straighten or replace bent metal parts.

(3) Inspect all screws, nuts, and lock washers to see if they are bent, broken, or have damaged threads. Remove burs with a fine mill file.

d. Installation (fig. 187).

(1) Position terminal block on unit (engine electrical system terminal block on instrument panel; alternating-current system terminal block on circuit breaker panel assembly channel).

(2) Install the two screws, lock washers, and nuts which attach terminal block to unit. Position designated strip in groove along center of terminal block and install the screws which attach strip to terminal block base.

(3) Connect wires to terminals of terminal block as shown in wiring diagram (fig. 141).

(4) Place cover in position on back of terminal block and install the four screws which attach cover to terminal block base.

114. FUSE BLOCKS.

a. Description (figs. 187 and 191). Two fuse blocks are used. They are of similar construction although one is designed to accommodate two fuses while the other is a single fuse model. Each fuse block consists of a bakelite base to which brass fuse clips and terminal assembly are attached by screws. The double fuse block is mounted on the circuit breaker panel assembly channel above the large terminal block. The single fuse block is attached to the rear of the instrument panel adjacent to the small terminal block. Capacity rating of the fuse blocks is 250-volts and 30 amperes.

b. Removal (fig. 187).

(1) Pull fuse or fuses from block and disconnect all wires from fuse block terminals.

(2) Remove the two screws which attach fuse block to unit (double fuse block to circuit breaker panel assembly channel; single fuse block to instrument panel).

c. Inspection and Repair.

(1) Inspect base to see if it is broken. If base is broken, replace the fuse block.

(2) Inspect clips and terminals to see if they are bent, broken, or corroded. Clean corrosion from contacts and terminals with class B flint paper, No. 2/0. Straighten clips and terminals if bent. Replace fuse block if clips or terminals are broken or if threads on terminal block or screws are stripped.

d. Installation (fig. 187).

(1) Position fuse block on unit (double fuse block on circuit breaker panel assembly channel; single fuse block on instrument panel). Install the two screws which attach block.

(2) Connect wires as follows:

(*a*) Single fuse block: to bottom terminal, wire No. 61 from terminal block; to top terminal, wire No. 63 from terminal block.

(*b*) Double fuse block: to lower left terminal, wire No. 2C from overload switch and wire No. 2C from terminal block; to upper left-hand intermal, wire No. 14 from instrument panel light switch and wire No. 14 from T-slot receptacle; to lower right-hand terminal, wire No. 2A from circuit breaker and wire No. 2A from terminal block; to upper right-hand terminal, wire No. 12 from instrument panel light switch, and wire No. 12 from T-slot receptacle.

(3) Push fuse or fuses into position in clips.

Section IV

VOLTAGE REGULATOR

115. DESCRIPTION (fig. 195).

a. The voltage regulator is installed on the rear of the instrument panel below the circuit breaker panel assembly. Its function is to automatically control the voltage of the generator output under varying load conditions. Fine adjustment enables the voltage regulator to keep the generator's output from varying, except momentarily, more than plus or minus 2 percent of its rated voltage.

b. A voltage coil, connected across two phases of the a-c generator, is energized by the generator output. This coil magnetizes a laminated iron core which attracts a vibrator reed. One of a pair of contacts is mounted on the vibrator reed so that when the vibrator is drawn to the core, the contacts are open. When the coil is not energized, the contacts close and short circuit a shunt field resistor. Because the generator delivers alternating current, the magnetic flux is pulsating. The vibrator pulsates 120 times per second. The contacts open slightly each time the voltage wave reaches a positive or negative maximum and close each time the voltage wave goes through zero.

c. Terminal voltage of the generator determines the length of time the contacts remain open during each pulsation. When the load is removed from the generator, the generator voltage rises. This opens the contacts for a longer period. The exciter shunt field resistor, therefore, is inserted into the field circuit of the exciter for a longer period. Thus, the alternator field excitation is cut, and generator output drops to normal. Generator terminal voltage drops when a

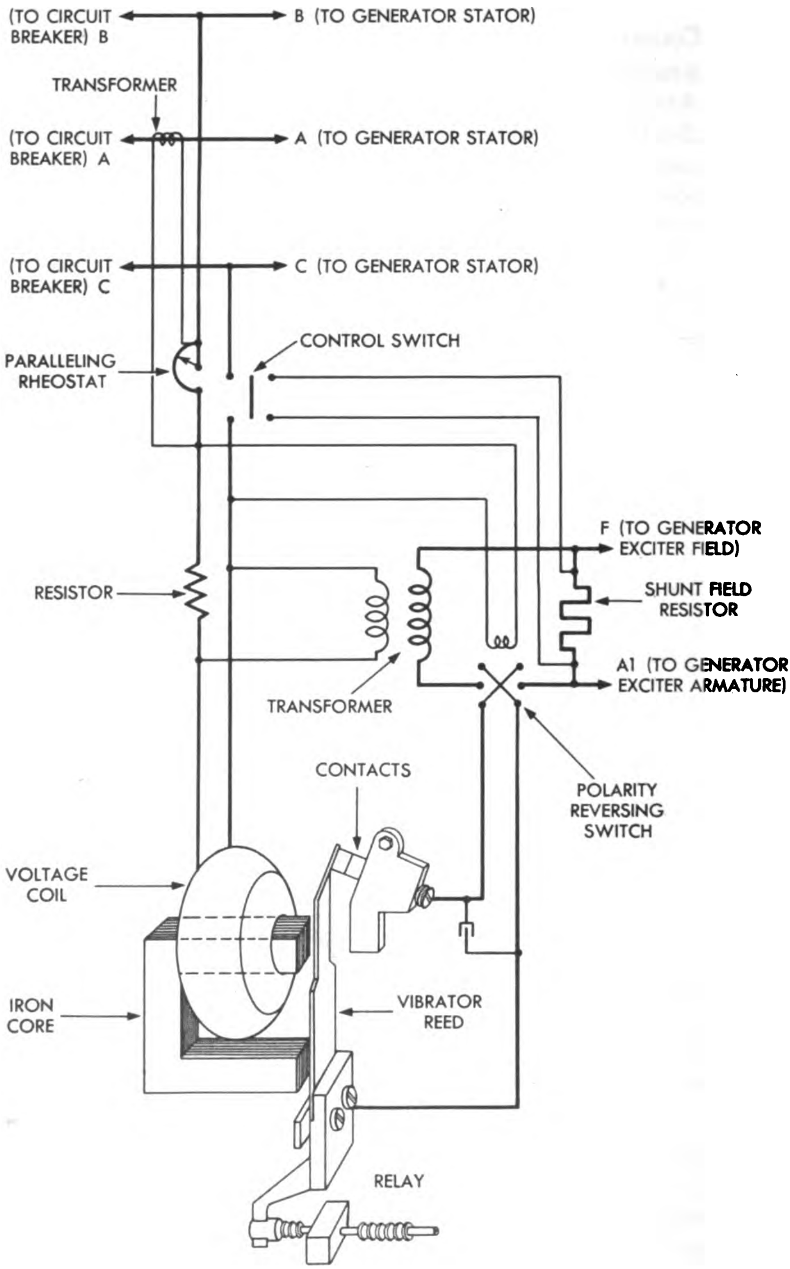


Figure 195—Voltage Control Wiring Diagram—Simplified

load is added to the generator. The contacts then remain closed for a longer period, or do not open at all. Since this shorts the shunt resistance in the exciter field, more excitation is delivered to the alternator field coils. This causes the output to rise quickly to normal.

d. A polarity reversing switch is provided to reverse the direction of the direct current through the contacts every 4 hours. This prevents excessive building up or pitting of the tungsten contacts. Sparking and improper wear of the contacts is further minimized by means of spark-suppressor condensers. These condensers are connected across the contact circuit.

e. Radio shielding is built into the voltage regulator in order to prevent interference with radio equipment. A grounded metal enclosure prevents radiation from the voltage regulator itself. Filter circuits prevent radiation from the leads which are brought out of the enclosure. Choke coils, having small values of inductance, oppose the flow of high-frequency currents. These coils have negligible effect upon either direct current or 60-cycle current. The condensers in the filter circuits block the flow of 60-cycle alternating current, but not the high-frequency currents. Thus, these condensers act like valves. They ground high-frequency currents, but oppose the flow of low-frequency or direct current to ground.

116. REMOVAL (figs. 187 and 141).

a. Remove tool box.

b. Disconnect the three bus bar connectors from terminals on circuit breaker panel assembly and load terminal box. Lift bus bars from unit.

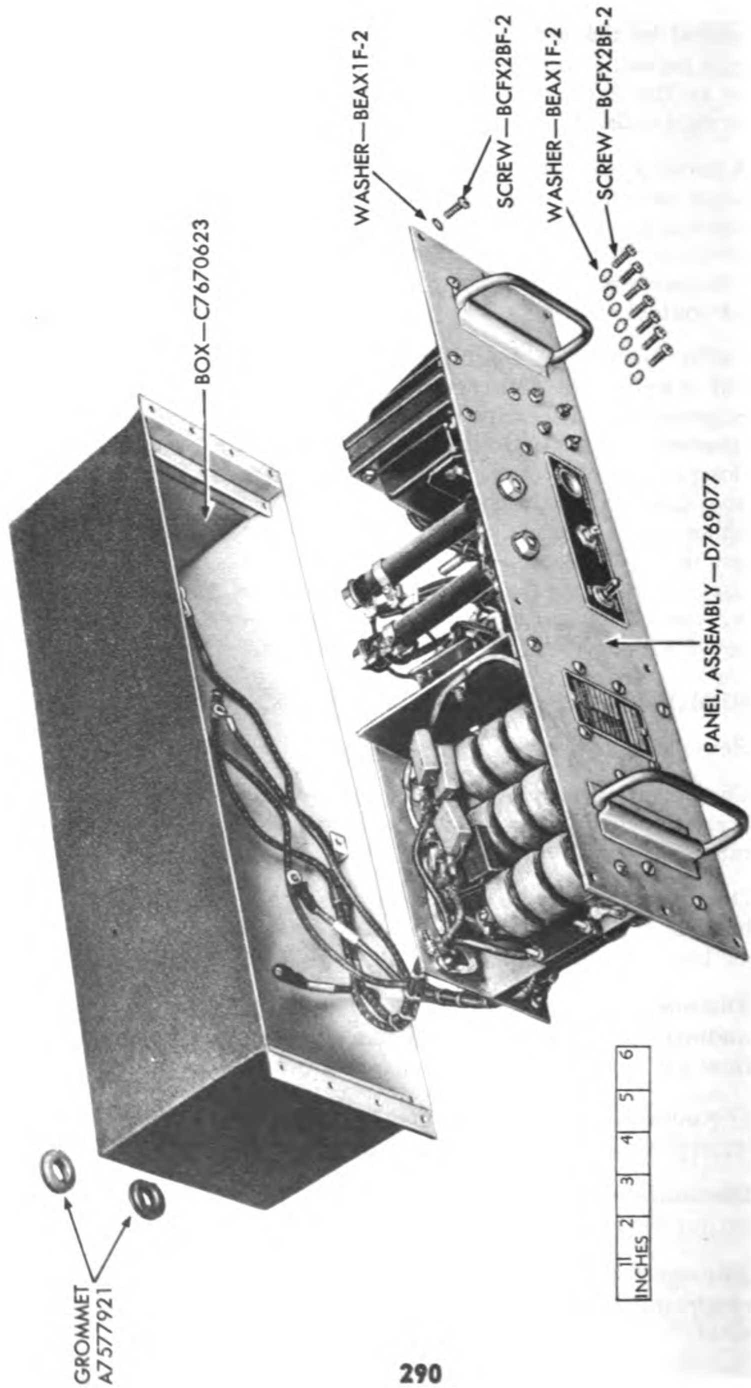
c. Disconnect main generator lead wires "A," "B," and "C" from circuit breaker panel assembly. Disconnect main generator lead wire "O" from load terminal box.

d. Disconnect voltage regulator lead wires "R5" and "R6" from correspondingly marked lead wires from cross-current compensating transformer on circuit breaker panel assembly.

e. Disconnect voltage regulator "2C," "2B," and "F" lead wires from corresponding terminals of terminal block.

f. Disconnect voltage regulator lead wire "R4" from "R4" terminal of exciter field rheostat.

g. Remove the eight flathead screws which secure voltage regulator to instrument panel. Lift voltage regulator from rear of instrument panel.



RA PD 78387

Figure 196—Voltage Regulator—Box Removed

117. DISASSEMBLY.

a. Only partial disassembly is given here. If it proves impossible to make needed repairs with the instructions given here, replace the entire voltage regulator.

b. Remove the eight screws and internal toothed lock washers which attach the panel assembly to the box. Lift box from rear of voltage regulator (fig. 196).

c. Pry the two rubber grommets from the wire exit holes in the rear of the box (fig. 215).

d. Remove relay assembly (under transformer) from panel as follows (fig. 198):

(1) Remove the nut, washer, and screw which attach ground wire to panel.

(2) Disconnect lead wires "7B" and "8C" from terminals on coil. Disconnect lead wire "B" from terminal on contact adjusting screw post. Disconnect lead wire "A" from screw which attaches it to insulated plate at center of bracket.

(3) Remove the four nuts, internal toothed lock washers, and screws which attach bracket to panel. Lift relay assembly from panel.

e. Remove transformer from panel as follows (fig. 198):

(1) Unsolder and remove lead wires "3C" and "3B" from transformer terminal "3."

(2) Unsolder and remove lead wire "0" from transformer terminal "4."

(3) Unsolder and remove lead wires "1" and "2" from transformer terminals "1" and "2" respectively.

(4) Remove the four nuts, internal toothed lock washers, and screws which attach transformer to panel. Lift transformer from panel.

f. Remove resistor A7576987 as follows (fig. 198):

(1) From terminal adjacent to panel, unsolder lead wires "3" and "3B."

(2) From terminal farthest from panel, unsolder and remove lead wires "4," "4B," and "4C."

(3) Remove nut, internal toothed lock washer, and brass washer from stud which attaches resistor to panel. Slide resistor from stud.

g. Remove resistor A7576986 as follows (fig. 198):

(1) From resistor terminal adjacent to panel, unsolder and remove lead wire "5" and unmarked wire from paralleling rheostat.

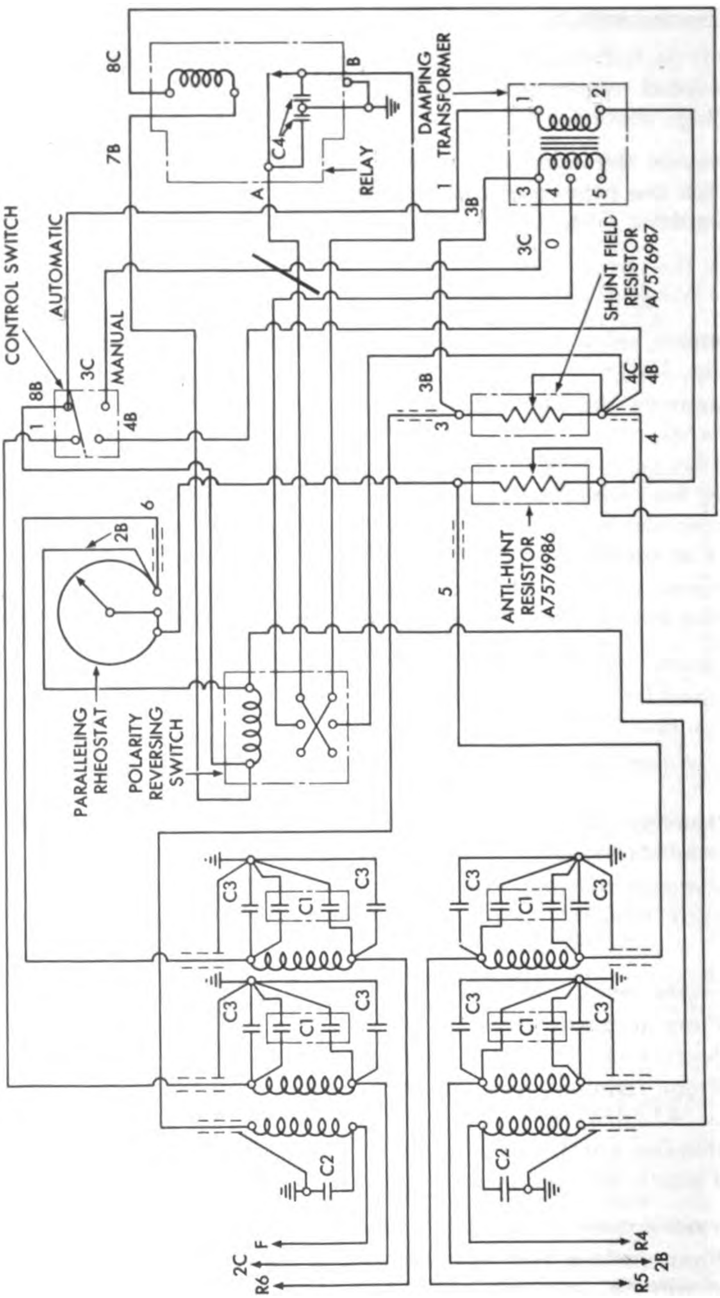


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Figure 197—Voltage Regulator Wiring Diagram

(2) From terminal farthest from panel, unsolder and remove two unmarked lead wires which come from relay and transformer.

(3) Remove nut, internal toothed washer, and brass washer from stud which attaches resistor to panel. Lift resistor from stud.

h. Remove paralleling rheostat A7577920 as follows (fig. 198):

(1) From contact terminal (center terminal), unsolder and remove unmarked lead wire which comes from resistor A7576986.

(2) From right-hand terminal (facing rear of rheostat), unsolder and remove lead wires "6" and "2B."

(3) On front of panel, remove nut which attaches rheostat to panel. With a long thin screwdriver, break solder to detach ground strip from panel between rheostat and rear of panel. Slide rheostat from panel.

i. Remove control switch A7576992 as follows (fig. 196):

(1) From lower left-hand terminal, unsolder and remove lead wire "3C."

(2) From lower right-hand terminal, unsolder and remove lead wire "4B."

(3) From upper left-hand terminal, unsolder and remove lead wire "8B" and unmarked lead wire which goes to the transformer.

(4) From upper right-hand terminal, unsolder and remove lead wire "1."

(5) From front of panel, remove gnurled switch retaining nut. Lift switch and internal toothed lock washer from rear of panel.

j. Remove polarity reversing switch B7635943 together with radio noise suppression units, as follows (fig. 198):

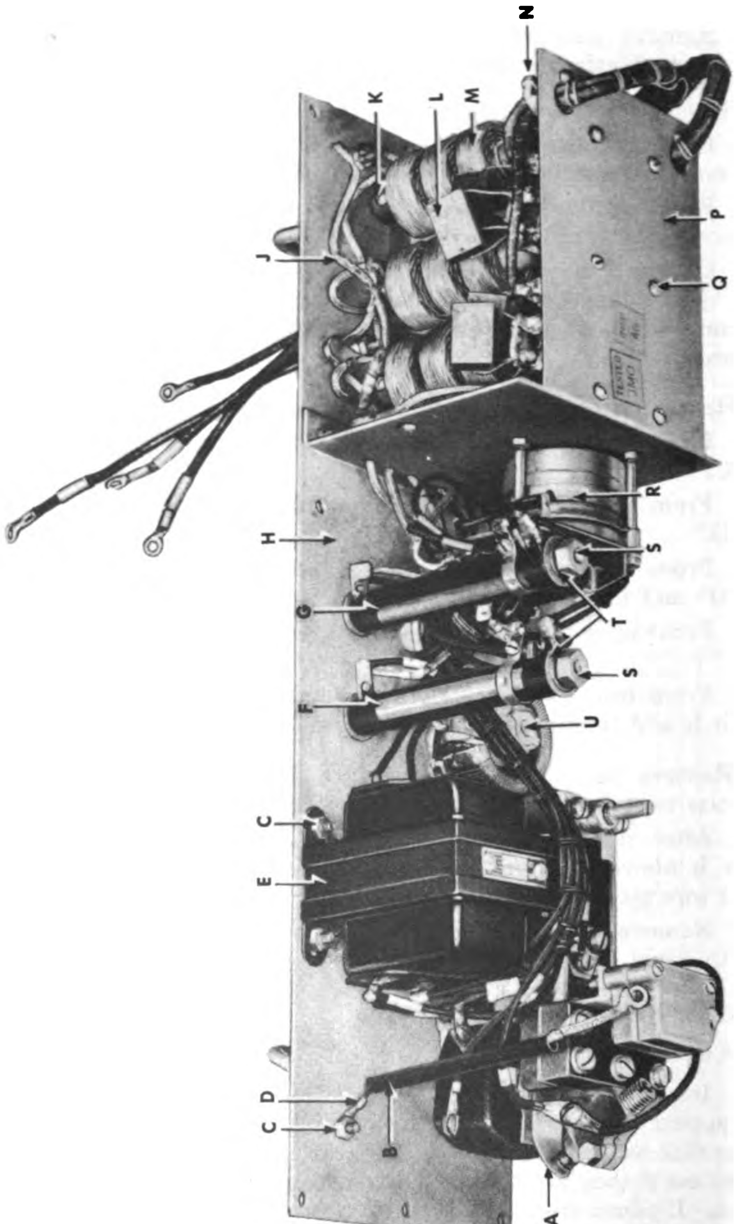
(1) After removing other units from panel, subparagraphs **a** through **h** above, remove the four nuts and screws which attach shielded wire grounding lugs to panel.

(2) Remove six nuts, screws, and lock washers which attach switch to panel. Lift switch assembly from panel.

118. INSPECTION AND REPAIR.

a. Contact Points.

(1) Inspect contact points to see if they are pitted or if sharp points appear on the face. Contact points consist of a 0.040-inch tungsten disk welded to a piece of steel the same diameter. Examine points to see if they are worn so that steel backing is visible through tungsten. If points are pitted or built up irregularly, dress them down on a fine oilstone. Replace contacts if steel backing shows through tungsten points, or if tungsten is worn to less than 0.005-inch thickness.



RA PD 78411

Figure 198—Voltage Regulator—Rear View With Box Removed

A—RELAY, ASSEMBLY—D7690101
B—TUBING, PLASTIC, NO. 3 x 3" LONG
C—SCREW—BCNX1FG-2
C—NUT—BBKX2BA-2
C—WASHER—BEAX1E
D—TERMINAL—A7575200
E—TRANSFORMER—B7635941
F—RESISTOR—A7576987
G—RESISTOR—A7576986
H—PANEL—B7636760
J—BRAID, COP., TN-PLTD., ⅛" x 5FT. LONG
K—SCREW, MACH., RD-HD., S., ZN-PLTD., NO. 6 (.138)—32NC-2 x 2⅝
K—NUT—BBKX2AA-2
K—WASHER—BEAXID
L—CAPACITOR—A7577009
M—COIL—B7636622
N—CLAMP—A7576985
P—BRACKET—B7636619
Q—SCREW—BCNX1EE-2
Q—NUT—BBKX2AA-2
Q—WASHER—BEAX1D
R—SWITCH—B7635943
S—STUD—A7576988
S—NUT—BBAX1A-2
S—WASHER—BEAX1H
S—WASHER—BEBX1BG
T—WASHER—A7576989
U—RHEOSTAT—A7577920

RA PD 78411A

Legend for Figure 198—Voltage Regulator—Rear View With Box Removed

(2) Replace contact points as follows:

(a) Unscrew stationary contact from adjusting screw and install new stationary contact.

(b) Loosen the two screws which clamp reed in position. Pull reed from relay. Slide new reed into position.

(c) Line up contacts and tighten the two clamp screws securely.

(d) Adjust reed to case air gap (step (3), below).

(3) Check and adjust air gap between reed and laminated iron core. Measure gap with 0.032-inch feeler gage. If necessary, adjust by screwing voltage regulator screw A7577003 to right or left until proper clearance is obtained. Then, check contact points to see if they are closed. If not closed, loosen clamp screw and turn stationary contact adjusting screw until contact is made. Tighten clamp screw.

b. Resistors. The capacities of the resistors are 200 and 500 ohms respectively. Capacity is marked on each resistor. Test each resistor with an ohmmeter. If ohmmeter shows reading under resistor capacity, a shorted resistor is indicated. Resistance in excess of resistor capacity indicates an open or partially opened circuit in resistor. Replace resistors which have shorted circuit or open circuit.

c. Paralleling Rheostat.

(1) Test paralleling rheostat for an open circuit with a test lamp. Place probes on center and right-hand (facing rear of rheostat) terminals. Turn contact from "OFF" position to full "ON" position. Test lamp should gradually grow brighter during process to full brightness with rheostat fully on.

(2) Inspect rheostat terminals, windings, and contacts to see if they are corroded. Remove corrosion with fine flint paper. Do not remove more wire from windings than absolutely necessary. Blow all dust from rheostat with compressed air.

d. Control Switch. Test across both poles of control switch with a test lamp. If lamp lights across either pole with switch off, or if lamp fails to light across either pole with switch on, replace switch.

e. Transformer.

(1) With a test lamp, test for continuity of circuit between terminals one and two, three and four, and four and five. Replace transformer if lamp fails to light on any test, as this would indicate an open circuit.

(2) Ground one probe of test lamp to unpainted spot on laminated core of transformer. Touch other probe to each terminal, one at a time. If lamp lights on any test, a grounded circuit is indicated. Replace transformer if grounded.

f. Polarity Reversing Switch.

(1) Inspect all connections on switch to see if any have come unsoldered or disconnected.

(2) Connect 60-cycle, 6-volt, current leads to motor leads. Watch switch-operating cam. A slight movement, at the rate of one revolution every 8 hours, indicates motor is functioning properly.

(3) With switch-operating cam in one of its two positions, test for continuity of its circuit from center terminal to both sets of end terminals with a test lamp. Lamp should light across one pair of poles only. Run motor until switch-operating cam is in other position and repeat test lamp test. Lamp should light across other pair of poles and not across pair on which lamp originally lighted. Replace switch if motor is inoperative or if switch does not function properly, as determined by test lamp checks.

(4) Test the 18 radio noise suppression choke coils for continuity of circuit with a test lamp. Place one probe on each lead. If lamp lights, no open circuit is indicated. Test choke coil for grounded circuit with a test lamp. Place one probe on coil lead, place the other probe on framework. If lamp lights, coil is grounded. Replace assembly if choke coils are grounded or have open circuits. Test coils for open circuit by running 6-volt direct current through each bank of three coils which are connected in series. Measure voltage drop by inserting needle pointed probes of voltmeter into leads from each coil, one coil at a time. Observe reading of voltmeter on each test. If voltage drop is appreciably less on any one coil, a shorted circuit is indicated within that coil. Replace assembly if choke coils are short circuited.

(5) Disconnect one connection of each radio noise suppression condenser. To test radio suppression condenser, connect in series a probe, a source of 90-volt direct current, a neon light, and another probe. Touch the two probes to the two leads from each condenser. Repeat test from ground terminal of condenser to each positive terminal of condenser if condenser has more than one positive connection. If lamps light continuously, a shorted circuit within condenser is indicated. If lamp fails to light at all, an open circuit within condenser or leads is indicated. If lamp blinks on and then goes out, a properly functioning condenser is indicated. Unsolder connections of improperly functioning condensers, and replace condenser with another of the same capacity. Capacity of condenser is stamped on each condenser. After making tests, solder negative lead to ground on each condenser.

119. ASSEMBLY.

a. Install Polarity Reversing Switch, Together With Radio Noise Suppression Units B7635943 (fig. 198).

(1) Position switch assembly on rear of panel. Install the six

screws, lock washers, and nuts which attach switch to panel.

(2) Attach each of the four shielded wire ground lugs to panel with screw and nut provided for the purpose.

(3) Install control switch, paralleling rheostat, resistor, transformer, and relay on panel (subpars. b through g, below).

b. **Install Control Switch** (fig. 196).

(1) Position switch in vertical position on rear panel with shaft through panel. Be sure internal toothed lock washer is properly positioned on switch shaft sleeve. Install narrowed switch retaining nut on front of panel.

(2) Solder lead wire "1" to upper right-hand terminal.

(3) On upper left-hand terminal, solder lead "8B" and unmarked lead wire from transformer.

(4) Solder lead wire "4B" to lower right-hand terminal.

(5) Solder lead wire "3C" to lower left-hand terminal.

c. **Install Paralleling Rheostat** (fig. 198).

(1) Position rheostat on rear of panel with shaft projecting through its hole in panel. Install nut on shaft sleeve in front of panel.

(2) Solder ground strip to panel between rheostat and panel.

(3) Facing rear of rheostat, solder lead wires "6" and "2B" to right-hand terminal.

(4) Solder unmarked lead wire from resistor A7576986 to center terminal. Check for presence of jumper wire from center to left-hand terminals.

d. **Install Resistor A7576986** (fig. 198).

(1) Slide resistor into position on right-hand (facing rear of panel) resistor stud. Install brass washer, internal toothed lock washer, and nut on the stud.

(2) Solder the two unmarked lead wires which come from relay and transformer to terminal most remote from panel.

(3) Solder lead wire "5" and unmarked wire from paralleling rheostat to resistor terminal adjacent to panel. Check for presence of jumper wire from terminal farthest from panel to clamp terminal toward center of resistor.

e. **Install Resistor A7576987** (fig. 198).

(1) Facing rear of panel, slide resistor onto left-hand resistor stud. Install brass washer, lock washer, and nut on stud.

(2) Solder lead wires "4," "4B," and "4C" to resistor terminal farthest from panel. Check for presence of wire jumper from this terminal to clamp terminal toward center of resistor.

(3) Solder lead wires "3" and "3B" to resistor terminal adjacent to panel.

f. **Install Transformer** (fig. 198).

(1) Position transformer on rear of panel with screw holes in transformer alined. Install the four screws, internal toothed lock washer, and four nuts which attach transformer to panel.

(2) Solder lead wire "2" to transformer terminal "2."

(3) Solder lead wire "1" to transformer terminal "1."

(4) Solder lead wire "0" to transformer terminal "4."

(5) Solder lead wires "3B" and "3C" to transformer terminal "3."

g. **Install Relay Assembly** (fig. 198).

(1) Position relay assembly on panel underneath transformer with screw holes in relay base and screw holes in panel alined. Install the four screws, internal toothed lock washers, and nuts which attach relay to panel.

(2) Connect lead wire "A" with screw which attaches it to insulated plate at top center of relay bracket.

(3) Connect lead wire "B" to terminal on contact adjusting screw post.

(4) Connect lead wire "7B" to coil terminal adjacent to transformer.

(5) Connect lead wire "8C" to coil terminal more remote from transformer.

(6) Slide plastic tubing onto relay ground wire and attach ground wire to panel with screw, lock washer, and nut.

h. **Install Box** (fig. 196).

(1) Snap the two rubber grommets into position in the two wire exit holes on the rear of the box.

(2) Set voltage regulator assembly in position in its box and install the eight internal toothed lock washers and screws which attach panel to box.

120. INSTALLATION (figs. 187 and 197).

a. Place voltage regulator in position on rear of instrument panel under circuit breaker panel assembly. Install the eight flathead screws which secure voltage regulator to instrument panel.

b. Connect voltage regulator lead wire "R4" to "R4" terminal of exciter field rheostat.

c. Connect voltage regulator wires "2B," "2C," and "F" to corresponding terminals of terminal block.

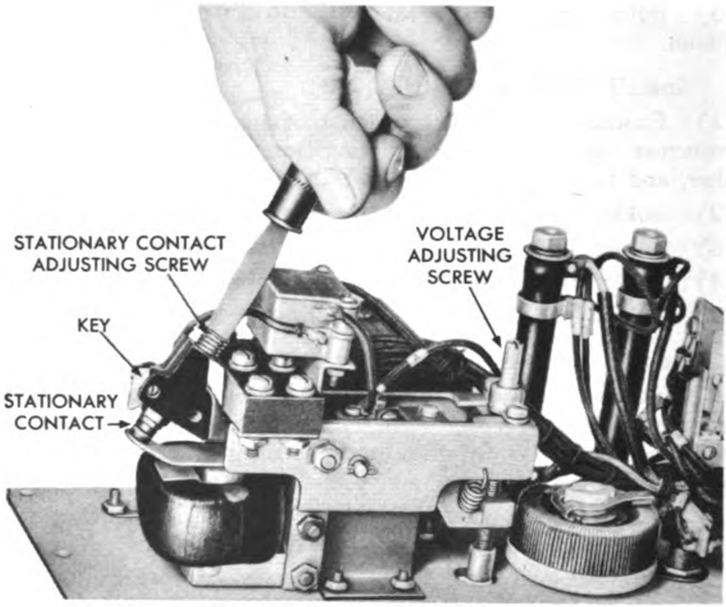


Figure 199—Voltage Regulator Contact Point Adjustment

d. Connect voltage regulator lead wires "R5" and "R6" to correspondingly marked lead wires from cross-current compensating transformer on circuit breaker panel assembly.

e. Connect main generator lead wires "A," "B," and "C" to "A," "B," and "C" terminals, respectively, of breaker panel assembly. Connect main generator lead wire "O" to "O" terminal on rear of load terminal box.

f. Position the three bus bars on "A," "B," and "C" bus bar terminals on circuit breaker panel assembly and on "A," "B," and "C" terminals on rear of load terminal box. Install the flat washers, lock washers, and nuts which attach bus bar to terminals. Be sure to connect power receptacle leads "A," "B," and "C" to "A," "B," and "C" terminals, respectively, on rear of load terminal box when connecting bus bar.

g. Install tool box.

121. ADJUSTMENTS (figs. 199 and 200).

a. Voltage Regulator Adjustment.

(1) Turn field rheostat to position of maximum excitation, therefore maximum voltage. Be sure main switch is off.

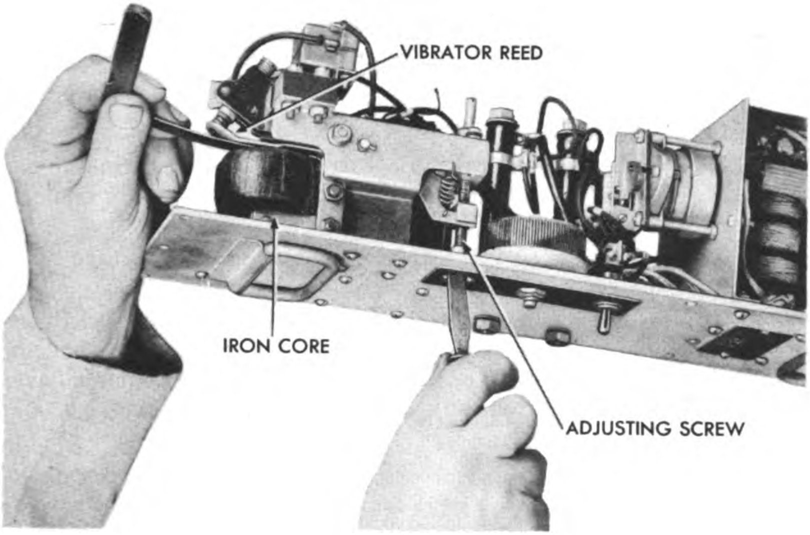


Figure 200—Voltage Regulator Air Gap Adjustment

(2) Lift voltage regulator cover (marked "Synchrostat") on front of instrument panel.

(3) Put the "ON-OFF" switch to the "ON" position.

(4) The paralleling rheostat should be adjusted to the normal setting. This setting is approximately one-half way between the "IN" and "OUT" positions. Count the number of turns between the two positions and set the rheostat at the midturn.

(5) Set the desired voltage by adjusting a-c voltage adjusting shaft. Then with main switch on and generator operating under load, make final adjustment of a-c voltage adjusting shaft for desired voltage.

b. Adjustment of Air Gap Between Vibrator and Laminated Iron Core (fig. 200).

(1) Remove front cover plate of voltage regulator.

(2) Remove eight screws and internal toothed local washers which hold voltage regulator box to panel. Pull out voltage regulator box, using the handles on the box. Movement of box is limited because of wires running into right side of box.

(3) The vibrator air gap is adjusted by turning the stationary contact adjusting screw clockwise or counterclockwise. (Clamping screw must be loosened before and tightened after working on stationary contact adjusting screw.)

(4) The air gap between the core and vibrator should be set to approximately 0.032 ($\frac{1}{32}$) inch. Air gap should be checked every 3 months.

c. **Maintenance of Regulator Contact Points.**

(1) The contact points are subject to some wear in normal operation. Adjustment of voltage adjusting shaft to compensate for contact wear must be made occasionally.

(2) Erratic voltage or inability to maintain normal voltage may indicate that the regulator contacts need attention.

(3) If inspection shows that contacts are quite pitted and there are sharp points on the surface, remove the contacts and dress them down with a fine emery cloth or fine oilstone. After the contacts have been dressed and reinserted, adjust the air gap if necessary.

CHAPTER 7

RADIO INTERFERENCE SUPPRESSION

122. DESCRIPTION.

a. General. During operation, the generating unit is a source of radio interference. It broadcasts radio waves. This is objectionable because it interferes with reception on nearby wireless equipment. It also enables the enemy to determine the exact location of the unit with detecting instruments. To overcome this handicap, units bearing serial numbers 96 to 138 inclusive were equipped to suppress radio interference. This suppression system consists of ground connectors, ignition shield, capacitors, and suppressors. Each is described as to construction and function in its subparagraph, below. In addition, shielded wire is used for the battery charging generator circuit (fig. 201) and for the ignition primary circuit (fig. 204). This is conventional type electrical wire with a flexible metallic loom covering the insulation. The loom is grounded to the framework of the unit to arrest radio interference.

b. Ground Connectors (fig. 203). Six ground connectors are used. Each connector is a woven metal flexible strap with a flat lug soldered to each end. A nut, lock washer, and bolt connect one connector to voltage regulator, generator terminal box, or to one of the four corners of the instrument panel. The other end of each connector is similarly attached to the housing and framework of the unit. Thus the connectors provide continuity of circuit between the instrument panel (with instruments) and the rest of the unit.

c. Shield (figs. 201 and 202). A sheet metal housing completely encloses the engine ignition secondary circuit—distributor, coil, spark plugs, and all high-tension wires. This housing or shield is grounded to the engine and arrests radio interference from the ignition system. The shield is of simple construction. Its sheet metal components are attached to each other with screws, lock washers, and nuts. The entire shield is attached to the engine by means of brackets which fit under heads of cylinder head cap screws.

d. Capacitors (figs. 201 and 204). Eight capacitors or condensers are used in the radio noise suppression system. One is mounted on the battery charging generator. Its lead wire is connected to the "CG" terminal of the two-charge regulator. Another capacitor is mounted adjacent to the ignition coil. Its lead wire is attached to the coil "IGN" terminal. The six remaining capacitors are mounted on top of the load terminal box. Their leads are connected to terminal box terminals or bus bar leads "A," "B," "C," "O,"

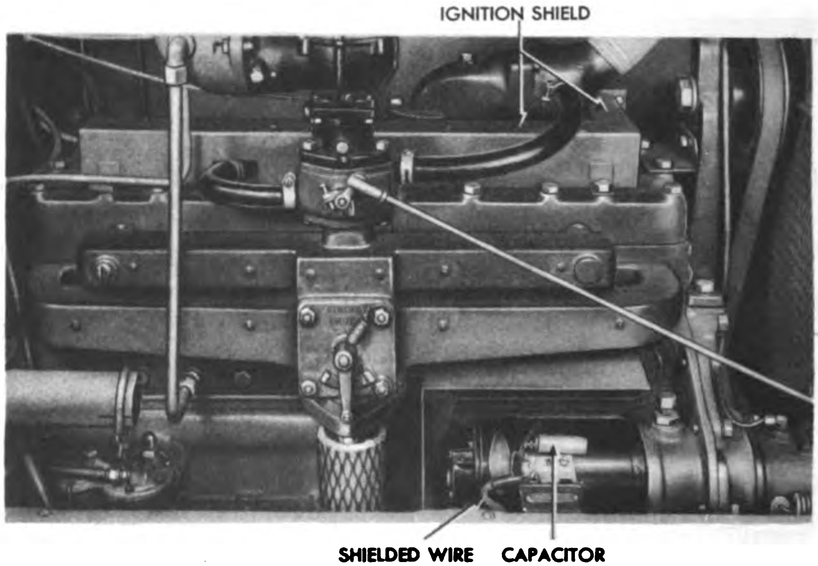


Figure 201—Radio Noise Suppression Units Installed on Engine (1)

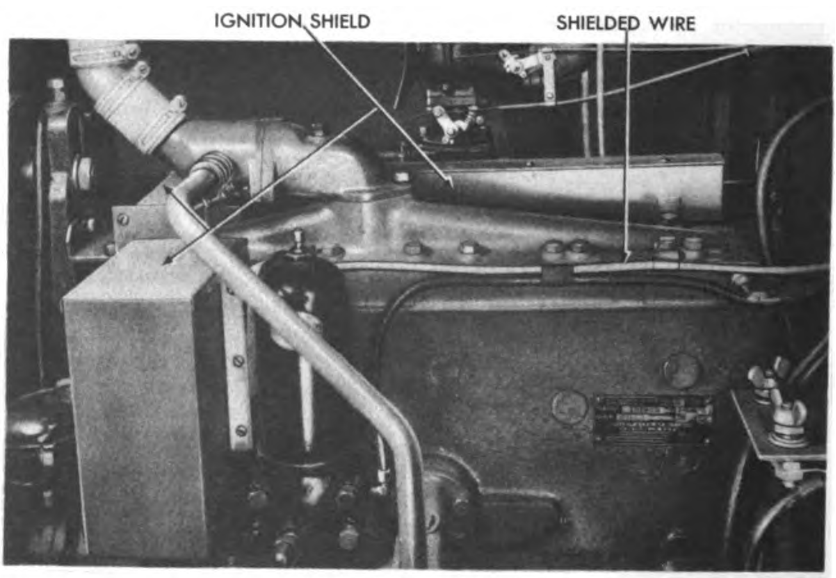


Figure 202—Radio Noise Suppression Units Installed on Engine (2)

and to terminal block terminals "CG" and "IGN," respectively. Each capacitor consists of two sheets of metal foil separated by an insulating sheet, rolled, and enclosed in a small cylindrical metal case. One sheet of foil is grounded to the case. The other is connected to the capacitor lead wire. Thus one sheet of foil is connected to each side of its circuit. This close proximity, yet complete separation, of the two sides of the circuit has a tendency to condense or intensify the current. It smooths out fluctuations and causes the flow of current to stop the moment the circuit is opened. This stops arcing and consequent radio noise every time the circuit is broken.

e. **Suppressors.** Seven resistor type suppressors are used. One is inserted in spark plug circuit above each plug. The remaining suppressor is attached to the coil in the secondary circuit. Each suppressor is a resistor. Its function is to check "dribbling" of spark before and after voltage builds up to deliver the main arcing necessary in the ignition system. This cuts down on radio interference without sacrificing ignition efficiency.

123. GROUND CONNECTORS.

a. **Removal** (fig. 203). Remove nut, lock washer, and bolt which attaches each end connector to unit. Lift connector from unit.

b. **Inspection and Repair.** Examine connector, bolts, lock washers, and nuts to see if any are bent or broken. Replace broken parts. Buff off contact surfaces of connector and surfaces which it contacts on unit.

c. **Installation** (fig. 203). Position connector on unit and install the two bolts, lock washers, and nuts which attach connector to unit. Tighten nuts securely.

124. SHIELD.

a. **Removal** (figs. 201 and 202).

(1) Remove nuts, lock washers, and screws which attach distributor and coil cover to rest of shield. Lift cover from shield.

(2) Disconnect "IGN" wire and condenser lead wire from coil.

(3) Remove nuts, lock washers, and bolts which attach shield to coil bracket.

(4) Remove cylinder head cap screws which secure shield to engine. Lift shield from engine.

b. **Disassembly** (figs. 201 and 202). Remove nuts, lock washers, and screws which hold together sheet steel components of shield, and separate the parts.

c. **Inspection and Repair.**

(1) Inspect sheet metal parts to see if they are bent or broken.

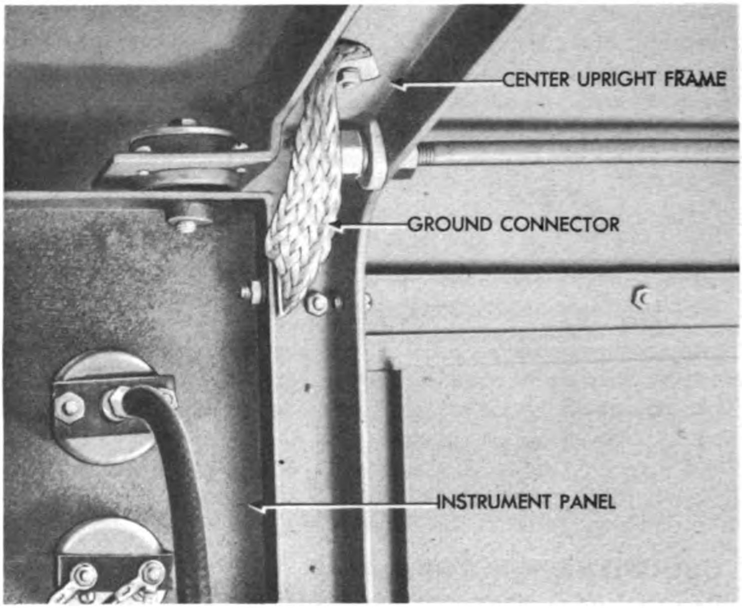


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Figure 203—Ground Connector Installed

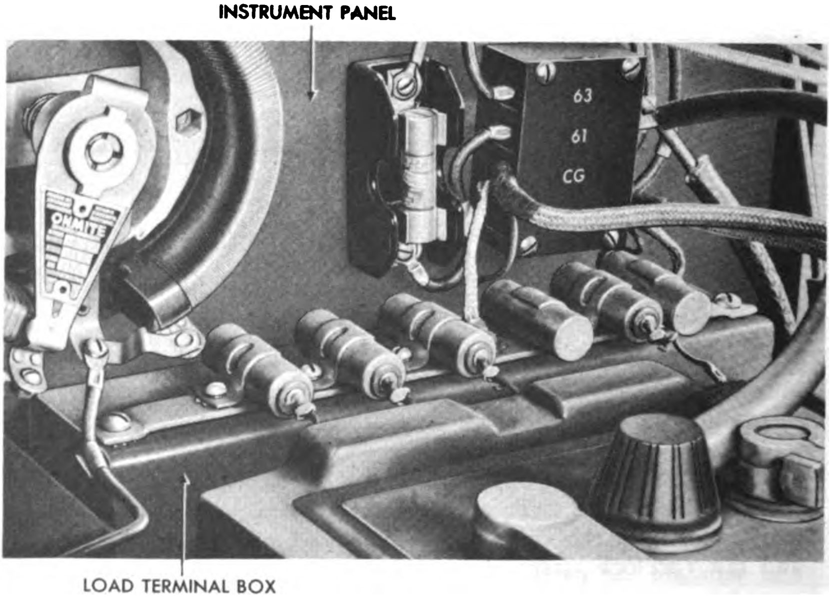

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Figure 204—Radio Noise Suppression Capacitors Installed

Bump bent parts to original shape. Replace or weld broken parts.

(2) Inspect all screws, nuts, and lock washers. These must be in perfect condition to prevent loose assembly which would render shield useless. Replace damaged parts.

d. **Assembly** (figs. 201 and 202). Place parts in position and install screws, lock washers, and nuts. Tighten nuts securely. Do not install distributor and coil cover until after installation of shield on engine.

e. **Installation** (figs. 201 and 202).

(1) Place shield in position on engine. Be sure all wires of ignition secondary circuit are enclosed. Install cylinder head cap screws which attach shield to engine.

(2) Install bolts, lock washers, and screws which attach shield to coil bracket.

(3) Connect "IGN" wire and capacitor lead wire to "IGN" terminal of ignition coil.

(4) Position distributor and coil cover on shield. Install screws, lock washers, and nuts which attach cover to shield.

125. CAPACITORS.

a. **Removal** (figs. 201 and 204).

(1) Disconnect capacitor lead wire from terminal or bus bar to which it is attached.

(2) Remove nut, lock washer, and screw (or screw and lock washer) which attach capacitor. Lift capacitor from unit.

b. **Inspection and Repair.**

(1) A short-circuited or ground capacitor will render inoperative the circuit to which it is connected. Disconnect lead and touch probes of test lamp to lead and to body of capacitor. If lamp lights, capacitor is shorted and must be replaced.

(2) Test for an open circuit by replacing capacitor with one known to function properly. If radio interference disappears, an opening in the original capacitor is indicated.

c. **Installation** (figs. 201 and 204).

(1) Position capacitor on generator terminal box, generator, or ignition coil, as the case may be. Install the screw, lock washer, and nut (or lock washer and screw) which attach capacitor.

(2) Connect capacitor lead wire to terminal or bus bar from which it was disconnected at time of removal.

126. SUPPRESSORS.

a. Removal.

(1) Remove nuts, lock washers, and screws which attach distributor and coil cover and spark plug cover to rest of shield. Lift covers from shield.

(2) Pull suppressors from spark plugs and ignition coil. Twist suppressors from ignition wires.

b. Inspection and Repair.

(1) Inspect suppressors to see if they are broken or if their terminals are corroded. Buff off corrosion. Replace broken suppressors.

(2) Test operation of suppressors by substituting them, one at a time, in the ignition circuit of an engine running without radio interference. Continued noninterference and otherwise satisfactory operation of the engine indicates suppressor is functioning properly. Replace suppressors whose functioning is unsatisfactory or questionable.

c. Installation.

(1) Insert ignition wires into ends of suppressor, and screw suppressor clockwise until tight. Push other end of suppressor onto its spark plug or into tower of ignition coil, as the case may be. Similarly install remaining suppressors. Be sure all suppressor connections are tight.

(2) Position spark plug cover and distributor and coil cover on shield. Install the screws, lock washers, and nuts which attach covers to shield.

CHAPTER 8

FRAME AND HOUSING

127. REPAIR OF FRAME (figs. 205 and 206).

a. If the frame should become damaged or warped, disassemble the housing and all removable units from the frame before attempting to repair. Before straightening or welding, clean with a wire brush, wash off with dry-cleaning solvent, and wipe dry with cloth. Examine for damage, paying particular attention to welds. Test doubtful welds with hammer. Inspect threads of tapped holes.

b. If frame is bent, straighten it if possible. Heat may be used, but do not heat above a cherry red. Either a sledge or an arbor press may be used to straighten members. If cold straightening is used, bend a trifle beyond true position and then bend back. This will overcome "set-back" in the metal.

c. If the frame is broken or cracked, or if the welds have become loose, repair frame by welding.

d. Clean burs from frame with a mill file. Clean up damaged threads with a tap.

128. DISASSEMBLY OF UNITS FROM FRAME, AND REPAIR OF HOUSING.

a. Remove doors, side panels, and hood. Examine metal for dents and cracks.

b. Remove fan guard and radiator (par. 28). Test radiator for leaks, and repair. Clean water passages and remove leaves, bugs, and other obstructions from air passages of core. Straighten fan guard if needed.

c. Remove gasoline tank. Clean, inspect for leaks, and repair.

d. Remove engine from frame (par. 58).

e. Remove generator from frame (par. 81).

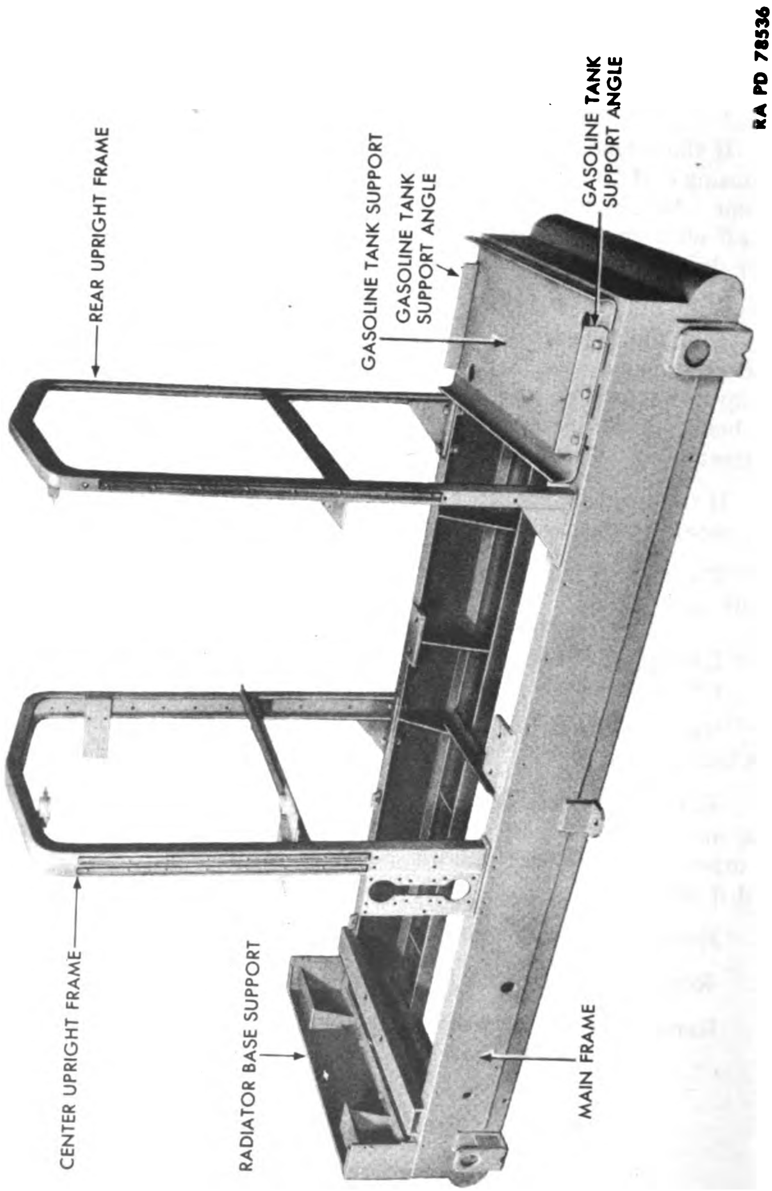
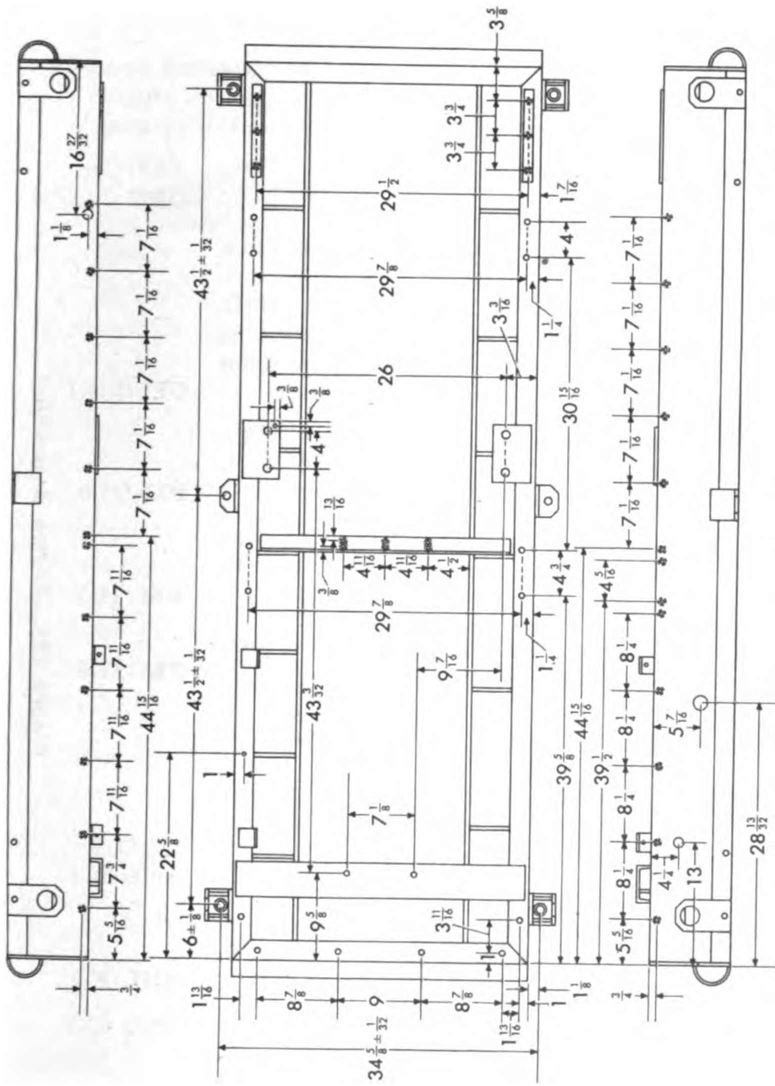


Figure 205—Frame Assembled



RA PD 78497

Figure 206—Main Frame Scale Drawing

CHAPTER 9

REFERENCES

129. PUBLICATIONS INDEXES.

The following publications indexes should be consulted frequently for latest changes or revisions of references given in this chapter and for new publications relating to materiel covered in this manual:

a.	Index (index to SNL's)	ASF Cat. ORD 2 OPSI
b.	Index to Ordnance Publications (listing FM's, TM's, TC's, and TB's of interest to ordnance personnel, OPSR, FSMWO's, BSD, S of SR's, OSSC's and OFSB's. Including alphabetical listing of ordnance major items with publications pertaining thereto)	OFSB 1-1
c.	List of Publications for Training (listing MR's, MTP's, FM's, TM's, TR's, TB's, MWO's, SB's, WDLO's and FT's)	FM 21-6
d.	List of Training Films, Film Strips and Film Bulletins (listing TF's, FS's, and FB's by serial number and subject)	FM 21-7
e.	Military Training Aids (listing graphic training aids, models, devices, and displays)	FM 21-8

130. STANDARD NOMENCLATURE LISTS.

a.	Cleaning, preserving and lubricating materials; recoil fluids, special oils, and miscellaneous related items	ORD 5 SNL K-1
b.	Harbor defense, railway and antiaircraft artillery sighting equipment and fire control instruments	SNL F-2
c.	Major items of antiaircraft artillery	SNL D-2
d.	Tools, maintenance, for repair of automotive and semi-automatic vehicles	ORD 6 SNL G-27
e.	Tool-sets for maintenance of sighting and fire control equipment	SNL F-272

REFERENCES

f. System, cable, M1 .... SNL F-207

g. System, cable, M3, M10 .... SNL F-244

h. Unit, generating, M18 .... SNL F-291

131. EXPLANATORY PUBLICATIONS.

a. Automotive Materiel.

Antiaircraft cable system and repair kits, all types and voltage controller M1	TM 9-649
Automotive electricity	TM 10-580
Automotive lubrication	TM 10-540
Chassis, body, and trailer units	TM 10-560
Fuels and carburetion	TM 10-550
Generator trailer M7 (to be superseded by TM 9-1881, when published)	TM 9-881
Generating unit M18	TM 9-617
Internal combustion engine, The	TM 10-570
Machinist, The	TM 10-445
Military motor vehicles	AR 850-15
Motor transport	FM 25-10
Motor transport inspections	TM 10-545
Ordnance storage and shipment chart-group F	OSSC-F
Sheet metal work, body, fender, and radiator repairs	TM 10-450
Storage of motor vehicle equipment	AR 850-18

b. Fire Control.

Instruction guide: Instrument repairman	TM 9-2602
Ordnance maintenance: Director M7, M7A1B1, M7A1B2	TM 9-1658
Ordnance maintenance: Directors M9 and M10, general maintenance; and computers M3 and M4	TM 9-1671A
Ordnance maintenance: Directors M9 and M10, power unit M8, tracker M2, and altitude converter M2	TM 9-1671B
Ordnance maintenance: Directors M9 and M10, wiring diagrams	TM 9-1671C
Ordnance maintenance: Director M9A2, wiring diagrams	TM 9-1671D
Ordnance maintenance: Electrical testing apparatus for fire control equipment	TM 9-1672

Ordnance maintenance: Height finder M1	TM 9-1623
Ordnance maintenance: Height finder M2	TM 9-1624
Ordnance maintenance: Remote control system M2	TM 9-1642

c. **Gun Materiel.**

90-mm antiaircraft gun materiel M1 and M1A1	TM 9-370
90-mm gun M1 and 90-mm antiaircraft gun mount T2E1	TM 9-371
120-mm gun M1 and 120-mm antiaircraft gun mount M1	TM 9-380

d. **Maintenance.**

Artillery lubrication, general	OFSB 6-4
Cleaning, preserving, sealing, lubricating, and related materials issued for ordnance materiel	TM 9-850

e. **Miscellaneous.**

Basic maintenance manual	TM 38-250
Decontamination	TM 3-220
Defense against chemical attack	FM 21-40
Hand, measuring, and power tools	TM 10-590
Instruction guide: Welding—theory and application	TM 9-2852

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PUBLICATIONS DEPARTMENT - RARITAN ARSENAL

TM 9-1618

WAR DEPARTMENT TECHNICAL MANUAL

ORDNANCE MAINTENANCE

GENERATING UNIT M7

WAR DEPARTMENT • 11 OCTOBER 1943

FOR ORDNANCE PERSONNEL ONLY

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WAR DEPARTMENT • 11 OCTOBER 1943

WAR DEPARTMENT
Washington 25, D. C., 13 December 1943

TM 9-1618, Ordnance Maintenance, Generating Unit M7, is published for the information and guidance of all concerned.

[A.G. 300.7 (9 Oct 43)
O.O. 461/46668 Raritan (13 Oct 43)]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:
J. A. ULIO,
Major General,
The Adjutant General.

DISTRIBUTION: R 9(4); Bn 9(2); C 9(5); IC 44(2)

(For explanation of symbols, see FM 21-6.)

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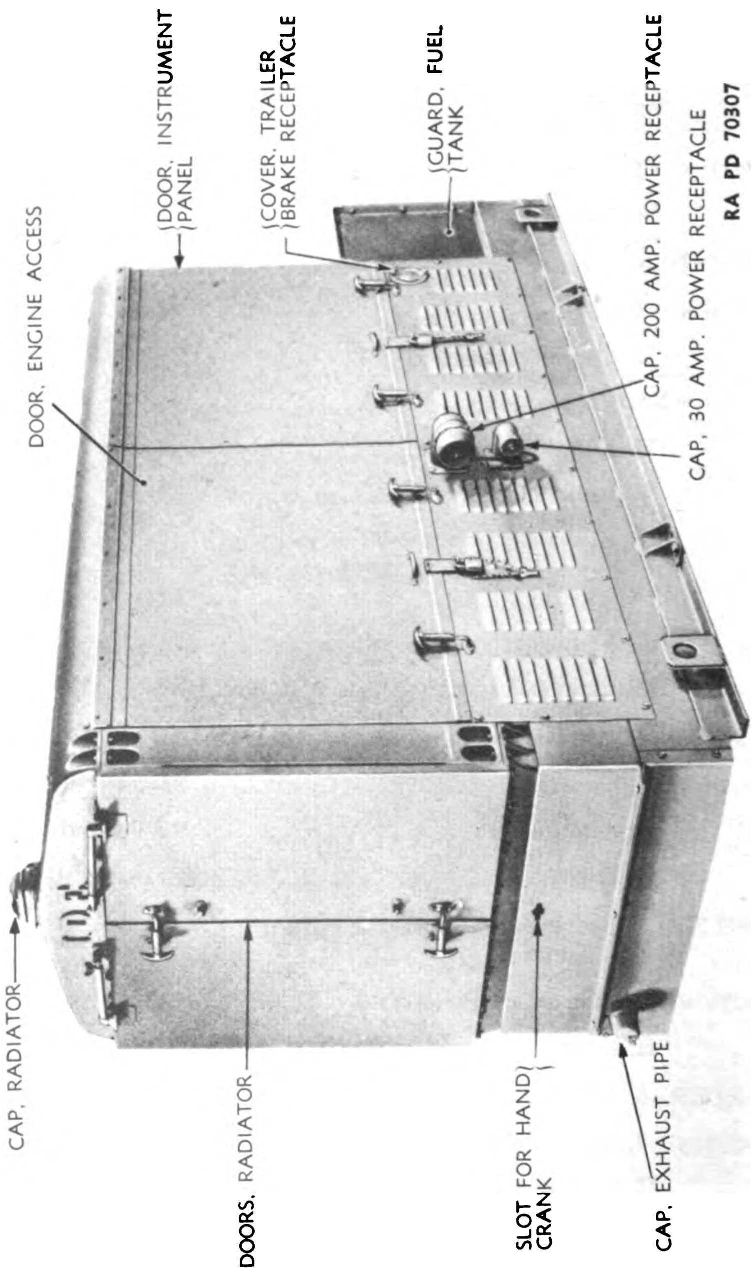

Figure 1 — Generating Unit M7 — Left Front View

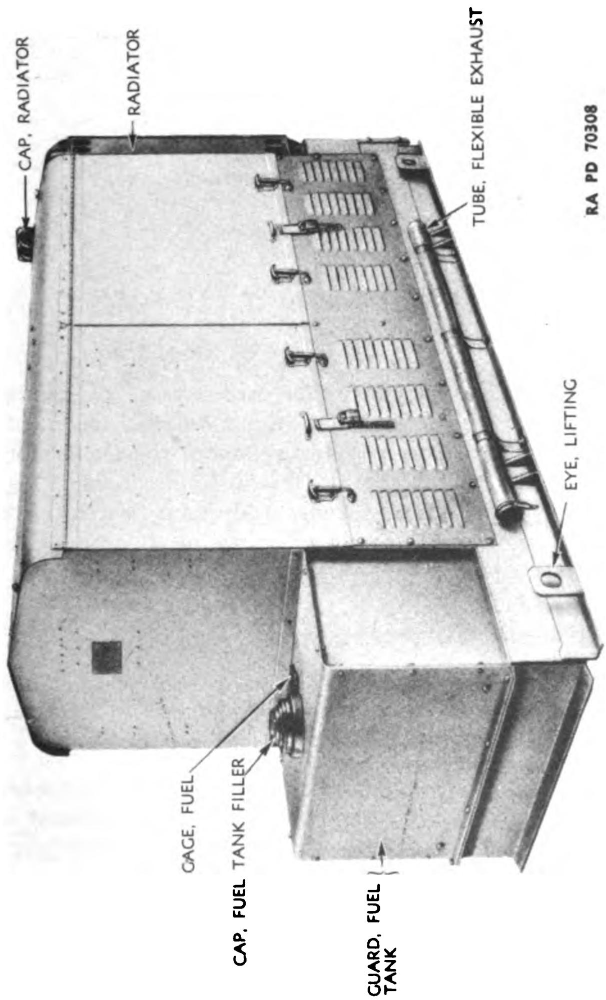

Figure 2 — Generating Unit M7 — Right Rear View

TM 9-1618

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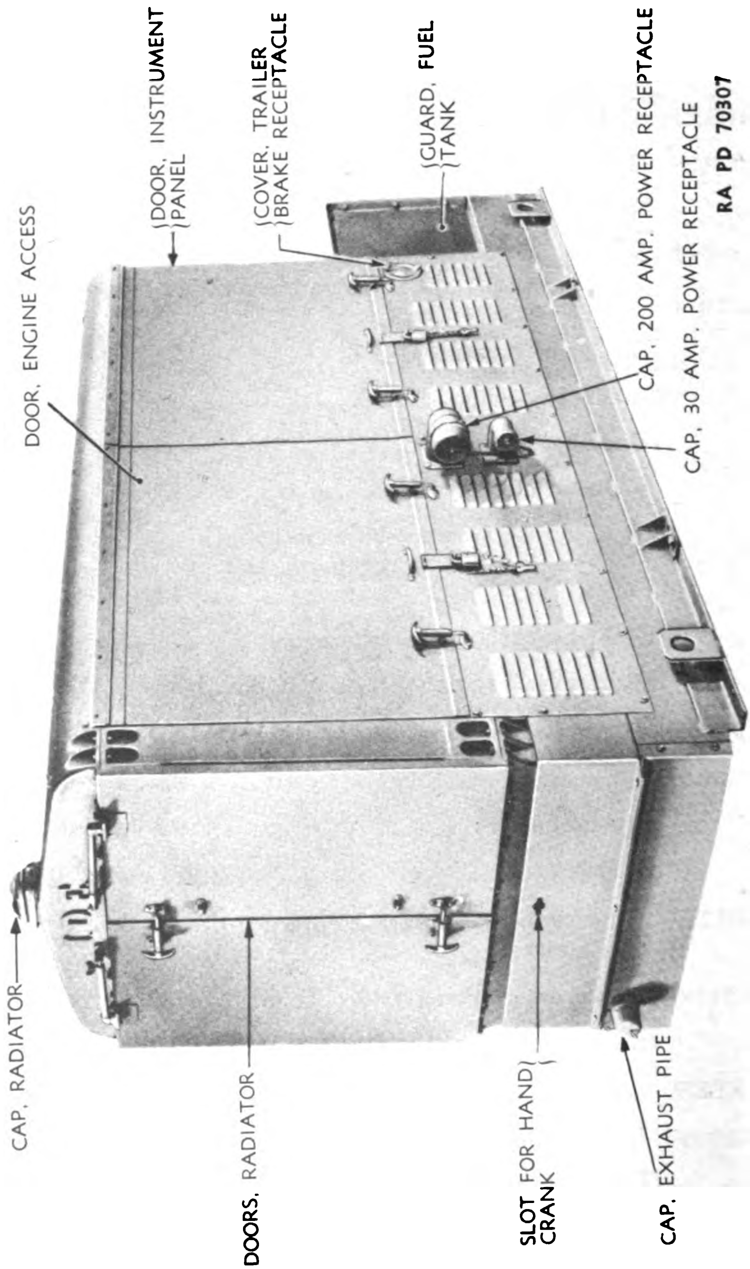


Figure 1 — Generating Unit M7 — Left Front View

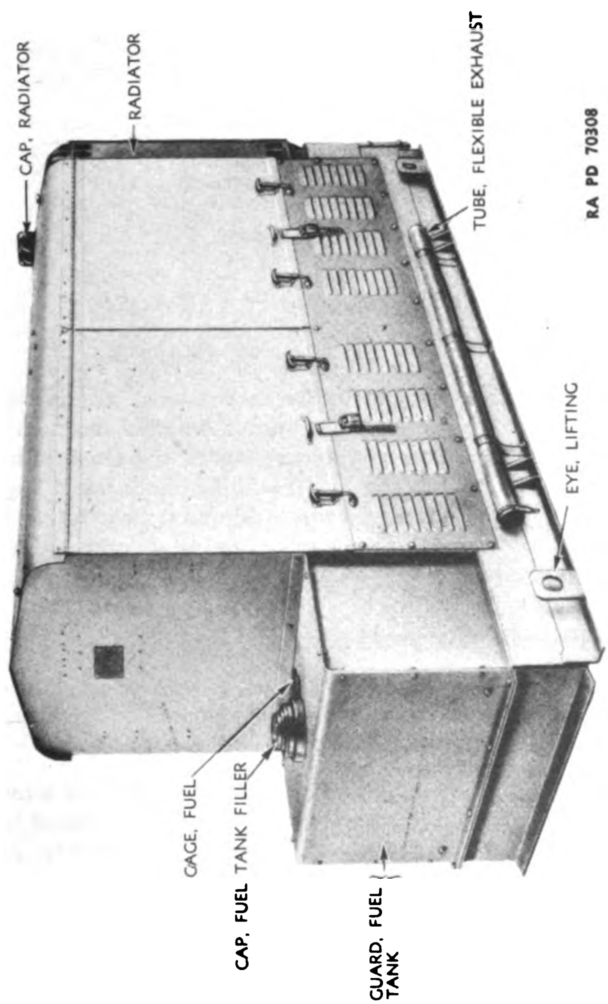


Figure 2 — Generating Unit M7 — Right Rear View

CHAPTER 1

INTRODUCTION

1. SCOPE.

a. This manual is published for the information and guidance of ordnance maintenance personnel. It contains detailed instructions for inspection, disassembly, assembly, and repair of the Generating Unit M7, supplementary to those in the Field Manuals and Technical Manuals prepared for the using arms. Additional descriptive matter and illustrations are included to aid in providing a complete working knowledge of the materiel.

2. ARRANGEMENT OF MANUAL.

a. This manual is divided into chapters, each chapter, with the exception of the first (Introduction) and the last (Miscellaneous), dealing with a major element of the generating unit.

b. Chapters are divided into sections and paragraphs which describe the materiel, explain its construction, and give detailed instructions for inspection, trouble shooting, removal, disassembly, maintenance, repairs, assembly, and installation. Certain accessories may be removed by the using arms. Removal of these accessories is described in TM 9-618 and not in this manual.

c. Chapter 6, Miscellaneous, gives general data applicable to the unit as a whole, and furnishes reference tables and guides.

3. REFERENCES.

a. Chapter 6, section III, lists all Technical Manuals, Standard Nomenclature Lists, and other publications relative to the materiel described herein.

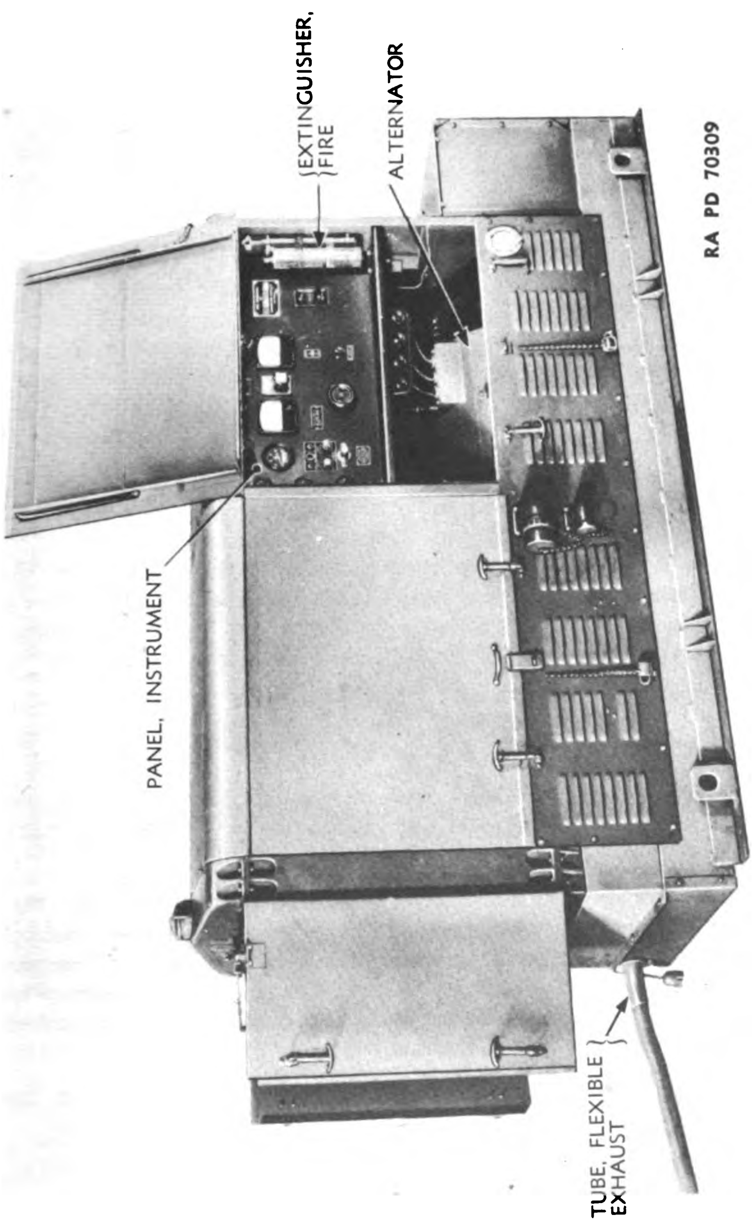


Figure 3 — Generating Unit M7 — Operating View

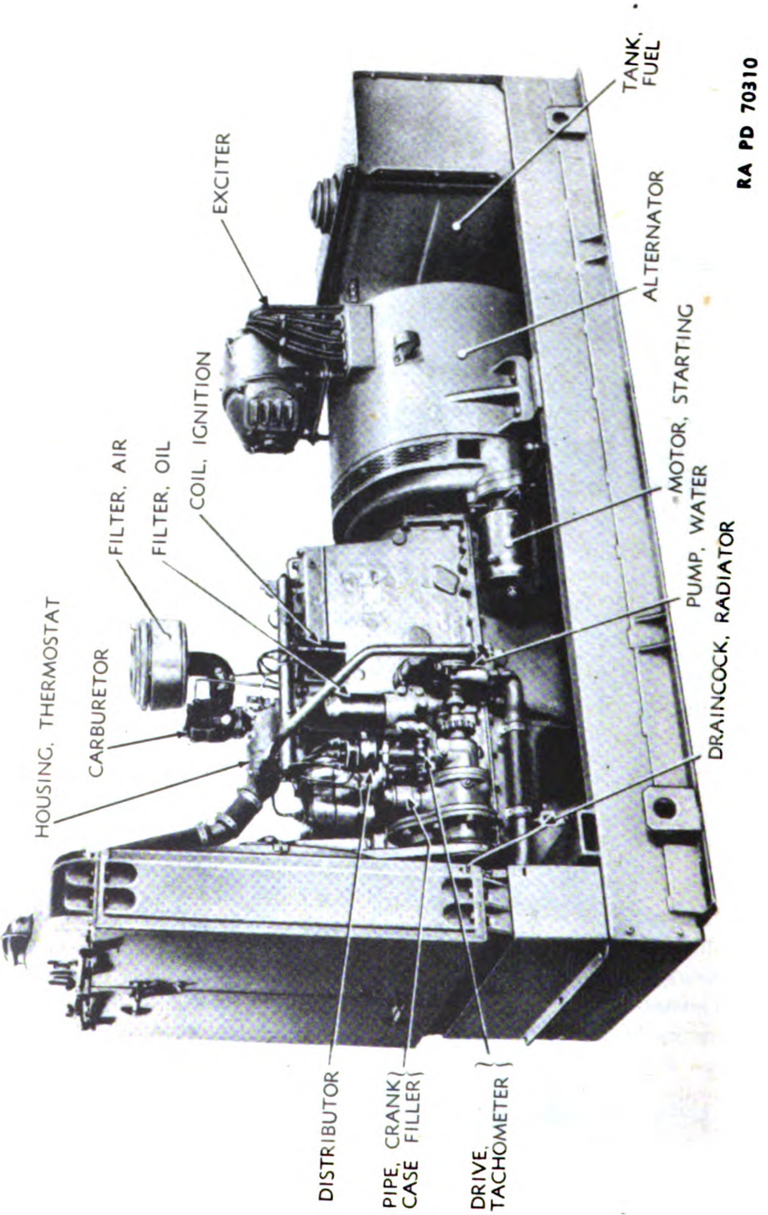


Figure 4 — Generating Unit M7 — Left Side: Housing Removed

INTRODUCTION

4. DESCRIPTION.

a. **General.** This unit (figs. 1 to 5) is a self-contained power plant mounted on a welded steel frame for use either on a specially designed trailer or set upon wood skids. The unit is completely enclosed by a sheet metal housing bolted to the base frame. Side doors give access to instrument panel, engine, generator, and other parts within the housing. The instrument and control panel is located over the alternator, on the left side of the unit. The radiator end of the unit is considered the front, and right and left sides are determined from the rear, facing toward the radiator.

b. **Engine.** The engine is a 6 cylinder, 4-stroke cycle, water-cooled gasoline engine developing approximately 67 hp at 1,200 rpm, and is directly connected to the alternator by a flexible coupling. It is equipped with an electric starting motor, battery-charging generator, oil bath air cleaner, oil filter, and gasoline strainer. Engine speeds are controlled by a mechanical governor.

c. **Alternator and Exciter.** The alternator is an a-c generator of the revolving field, stationary armature type, with separate excitation provided from a d-c generator, either mounted on the top of the alternator housing or placed inside the same housing and mounted on the same shaft. At 1,200 rpm, it delivers 35 kva-162 amperes at 125 volts, 3 phase.

d. **Controls.** Controls are mounted on an instrument panel immediately behind the left rear door of the unit. Engine controls are grouped on the left side of the panel. These consist of an oil pressure gage, temperature gage, starter switch, ignition switch, throttle, choke, tachometer or frequency meter, and the battery-charging generator ammeter with –30 to +30 ampere range. On some units an electric fuel gage is also mounted on the instrument panel. Most units make use of a mechanical float-type gage mounted directly on the fuel tank. To the right are the generator and line controls. These consist of the main, or load switch, power ammeter with 0 to 250 range, power voltmeter with 0 to 150 range, meter switch for obtaining phase readings, and field rheostat with tapered resistance of 100 ohms, maximum ampere rating 3.16, minimum 1.23. Illumination is provided by two 125-volt lamps at the top of the panel. As these will function only when the unit is in operation, auxiliary lighting is provided by a 6-volt light from the battery circuit, also at the top of the panel. Toggle switches control both lighting systems. A lamp-dimming rheostat is set between the 125-volt lights. In the engine control group at the left is a receptacle for the 6-volt trouble light. A T-slot receptacle for the 125-volt trouble light is at the right, and four more T-slot receptacles, for power tools, etc., are provided in the instrument panel apron. For convenience, the fire extinguisher is mounted at the right of the panel.

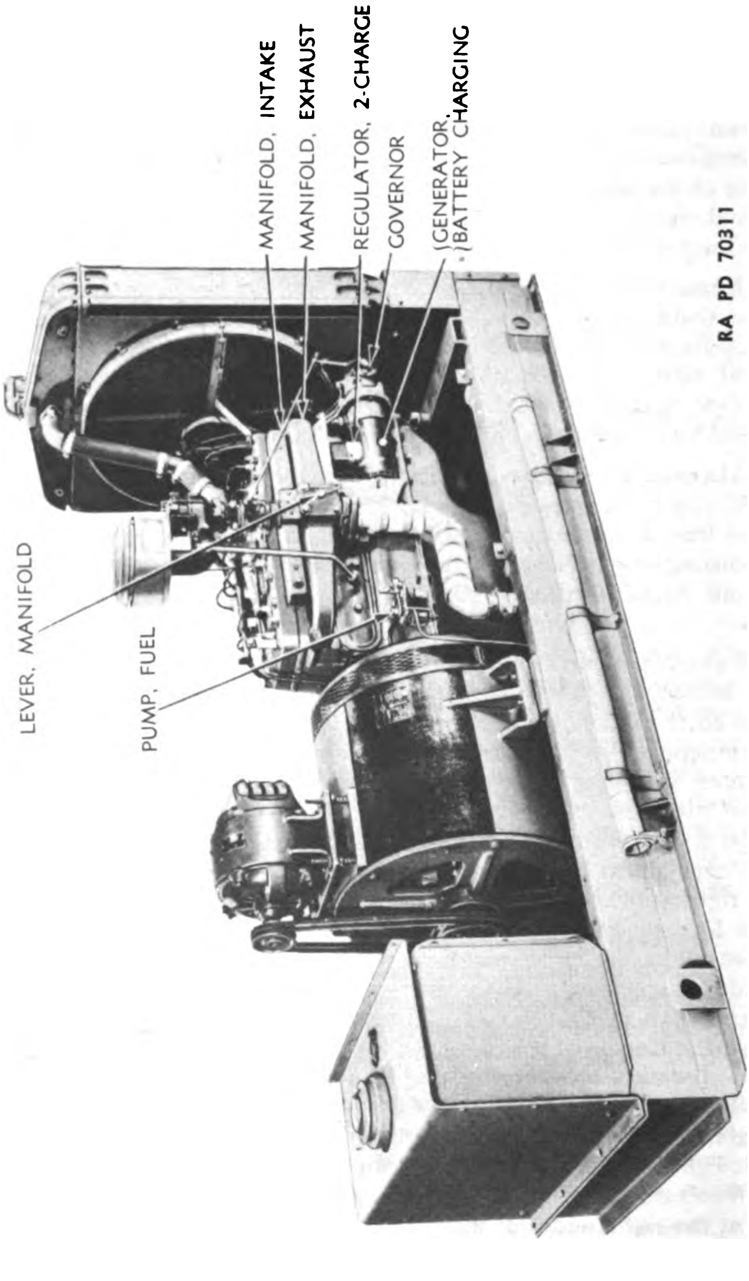


Figure 5 — Generating Unit M7 — Right Side: Housing Removed

INTRODUCTION

5. DIFFERENCES AMONG MODELS.

a. Generating Units M7 have been produced by several manufacturers. Information and instructions given in this manual cover all M7 Units. Whenever, with units of certain manufacture, major differences in equipment occur, or changes in procedure are necessary, supplementary information or instructions are given, identified by the initials of the manufacturer. There are no primary differences in manufacture which would affect troop use or care, with the exception of the Hobart Bros. Co. unit, which has the exciter mounted on the same shaft and within the same housing as the alternator rotor.

b. **Generating Unit M7A1.** The designation Generating Unit M7A1 has been assigned to all Generating Units M7 which have been modified by the addition of a voltage regulator to the unit. The voltage regulator is designed to hold the voltage variation to within ± 2 percent from full load to no load operation.

6. ALLOCATION OF MAINTENANCE DUTIES BY ECHELONS.

a. The outline below assigns specifically to each echelon its duties and functions in the proper care and maintenance of the generating unit. All echelons of maintenance should be capable of performing all lower echelons of maintenance. Maintenance in the field is necessarily a flexible matter. In a combat zone, where there is immediate danger of enemy attack, the organizational specialist, if qualified, would be perfectly correct in performing emergency third echelon repairs if no maintenance company is available. When, under field conditions, both the using arms and the ordnance maintenance troops must use their discretion as to how best to accomplish their maintenance mission. However, extreme care must be exercised if a lower echelon attempts the work of a higher one. Attempts at repair work that belong in higher echelons of maintenance may result in damage to the materiel.

b. **Echelons are Defined as Follows.**

(1) FIRST ECHELON. This consists of the personnel actually using the materiel (e.g., the gun crew). Proper care of the materiel, cleaning, lubrication, and a limited number of minor repairs are performed by this echelon. Preventive maintenance is the keynote here.

(2) SECOND ECHELON. This consists of the maintenance personnel in the company, battalion, regiment, or corresponding units in the using arms or services, and it performs limited unit replacement, lubrication, and minor repairs.

(3) THIRD ECHELON. Maintenance is normally performed by ordnance medium maintenance or antiaircraft maintenance companies using standard issued mobile equipment. Some activities of this

echelon are replacement of unit assemblies, overhaul of accessory unit assemblies and subassemblies, recovery of materiel, and evacuation. This maintenance is performed by ordnance personnel or ordnance medium maintenance units for the organizations they serve. The supply of spare parts to lower echelons is also a function of these medium maintenance companies.

(4) FOURTH ECHELON. This normally consists of ordnance heavy maintenance companies or post ordnance shops (other than base shops) having facilities for performing major disassemblies and heavy maintenance.

(5) FIFTH ECHELON. This normally consists of personnel of arsenals and authorized base shops with facilities for performing complete overhaul.

c. Maintenance Allocations.

(1) FIRST ECHELON.

Maintain oil level in crankcase.

Maintain gas in tank.

Maintain air pressure in tires, and make tire repairs.

Maintain battery water level.

Maintain radiator water level.

Adjust louvers for proper operating temperature.

Renew fuze links.

Clean gasoline pump sediment bowl.

Replace lamps.

(2) SECOND ECHELON.

Grease, oil, and lubricate.

Clean or replace air and oil filters.

Adjust "rate of charge" of battery-charging generator.

Adjust engine governor.

Clean and adjust distributor points.

Clean and flush radiator and cooling system.

Repack water pump.

Adjust or replace fan or generator belts.

Clean spark plugs, and adjust gaps.

Adjust or replace exciter belts.

Replace battery.

Check and tighten all electrical terminals.

Adjust oil pump pressure.

Adjust spring tension, or replace brushes on starter motor, battery-charging generator, exciter, and/or alternator.

INTRODUCTION

Replace the following engine and generator accessories:

Spark plugs and ignition wiring.
Spark coil.
Intake and exhaust manifolds.
Fan assembly.
Starter.
Starter Bendix spring.
Battery-charging generator.
Battery-charging voltage regulator generator.
Water-cooling system hose.
Water-cooling system thermostat.
Water pump packing.
Oil gage.
Oil lines and fittings.
Oil strainer.
Battery cables.
Lighting switch.
Starting switch.
Tachometer.
Muffler.
Exhaust pipe.
Throttle control.
Choke control.
Carburetor.
Throttle box.
Distributor rotor.
Condenser.
Distributor points.
Ammeter.
Battery-charging ammeter.
Fuel pump.
Fuel gage.
Light receptacles.
Field rheostat.
Switches.

(3) THIRD AND FOURTH ECHELONS.

General repair, including valve grinding, carburetor repair, distributor repairs and adjustments, etc., but not including rebores, piston, bearing, or rod work.

Replace electrical or mechanical parts or assemblies.
Replace wheels, repair brakes, etc., on Generator Trailer M7.

(4) FIFTH ECHELON.

Perform all necessary repairs or replacements which cannot properly be done by lower echelons.

7. INSPECTION.

a. **Description.** Inspections by ordnance personnel are a follow-up and check on organization maintenance inspections and other maintenance functions. They determine whether the unit should be continued in service or withdrawn from operation for overhaul. These general inspections are similar to the monthly inspections described in TM 9-618.

b. **Inspection Record.** A permanent record, listing any maintenance performed, should be kept of each inspection. A suitable inspection form, listing the points of inspection itemized, can be prepared as a guide for maintenance personnel. Utility of the form will be increased if space is provided to record the date and remarks for each periodic inspection.

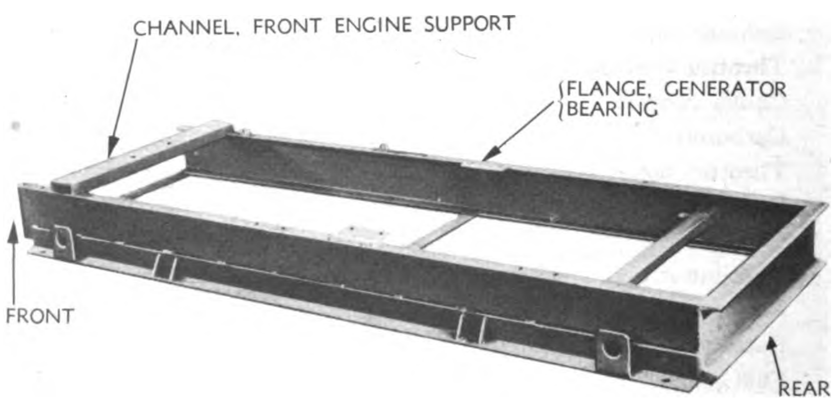


Figure 6 — Frame — Stripped

CHAPTER 2

FRAME AND HOUSING

Section I

FRAME

8. DESCRIPTION.

a. The frame (figs. 6 and 7) is of welded steel construction, and is made up of four side members and six cross members. Centrally located pads braced by gusset plates provide bearing for the alternator. Lifting eyes are welded to the outer angles. Some units depart from the general design in that the generator bearing pads are replaced by a removable squared C-shape strap with pads at each end. This allows a variation in the method of assembling the unit.

b. **Frame Dimensions** (fig. 7).

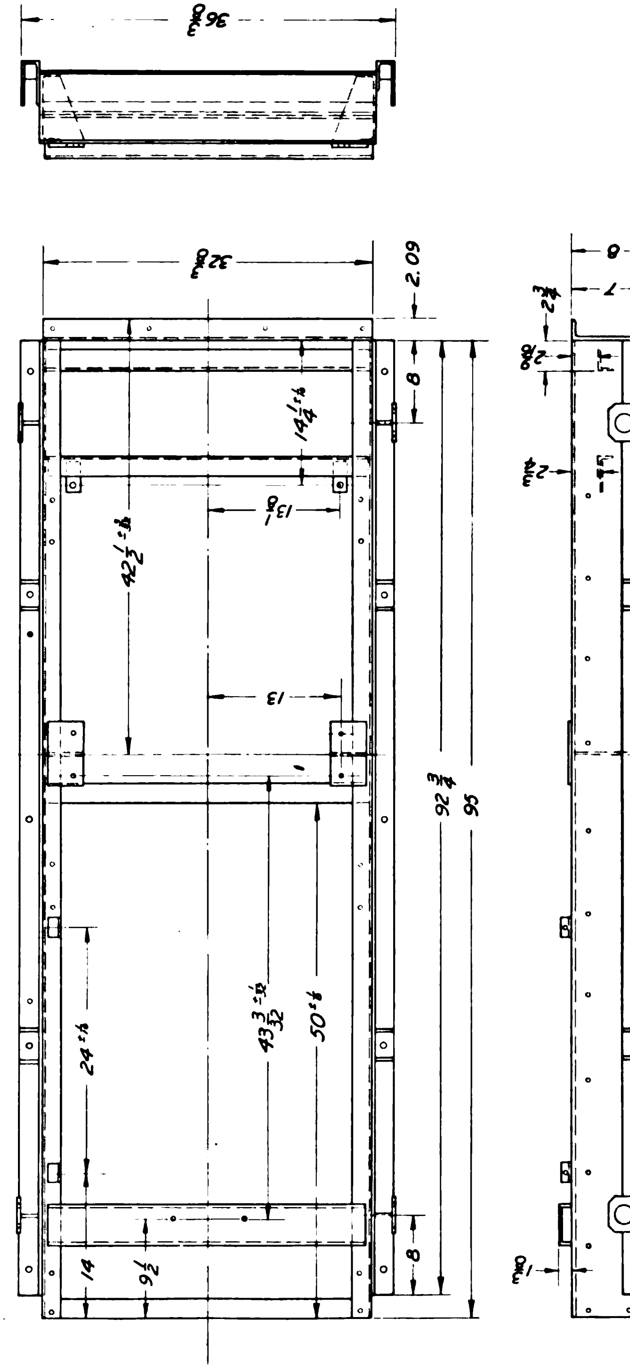
Over-all length	97 1/8 in.
Width	36 3/8 in.
Distance between centers of engine mounting holes	11 in.
Distance between centers of each pair of alternator mounting holes	26 in.
Distance between centers in each pair of alternator mounting holes	4 in.

9. INSPECTION AND REPAIR.

a. **Procedure.**

(1) With all parts removed from frame, visually inspect welded joints. Repair any broken welded joints.

(2) Check corners with square. Check dimensions. If not according to specifications, replace or repair.



RA PD 70313

Figure 7 — Scale Drawing of Frame

Section II

HOUSING

10. DESCRIPTION.

a. From the radiator back, the entire unit is enclosed by a 16-gage sheet metal housing made up of four access doors, two side panels, an end panel, the roof, a fuel tank guard, and two fuel tank end panels. All housing components can be removed for replacement or repair.

b. Sheet metal radiator doors provide radiator protection, and form part of the cooling system.

11. REMOVAL.

a. There are several methods of supporting the power and brake receptacle leads and the alternator leads, etc., to each other and to either the housing or alternator. Examination before disassembly will reveal the proper method of uncoupling these leads, and also simplify reassembly.

b. Procedure.

(1) Disconnect the instrument panel. For procedure, refer to paragraph 105, *omitting* step (12).

(2) Loosen hold-down clamp nuts, and remove clamps. Loosen battery lead clamps, and remove leads from battery posts. Remove battery and inside tray. Remove nuts from cap screws through battery box flanges (fig. 8), and lift box off. Remove nuts from bolts through bottom of tool box, and remove box.

(3) Remove nuts and cap screws holding guard to rear housing panel. Remove cap screws holding guard to frame base. Remove nuts from strap-end bolts attaching fuel tank traps to frame cross member behind housing rear panel (fig. 86). Lift guard up and off.

(4) Remove nut holding back of brake receptacle housing. Remove nut attaching lead, and remove lead.

(5) Take out cap screws and nuts holding housing roof to radiator. Remove bottom cap screw and nut at each side of radiator holding side panels to radiator.

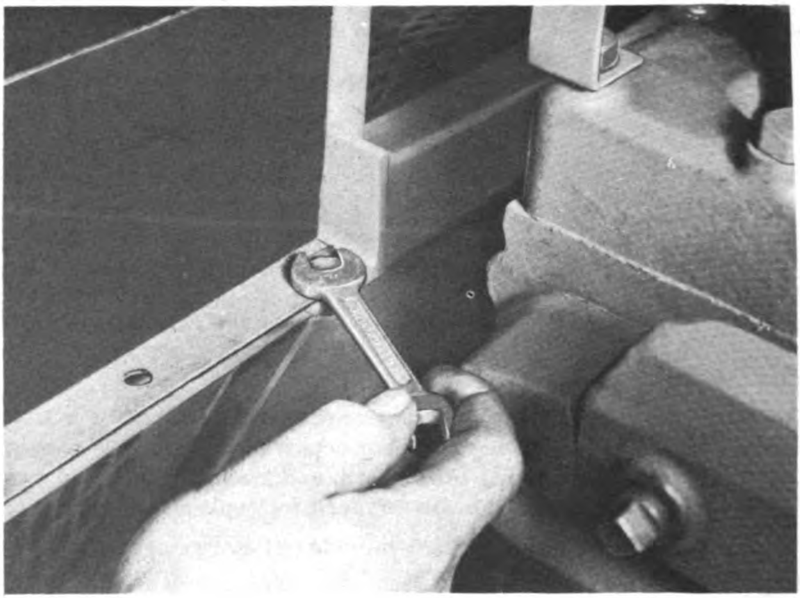


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Figure 8 — Battery Box Removal

(6) Remove nuts which secure each radiator support rod to center bow, by holding rod with pliers while unscrewing nuts at bow. Unscrew rod from radiator, and remove (fig. 11).

(7) Remove cap screws and nuts attaching side panel to frame, radiator support panel, and exhaust guard tray.

(8) Remove cap screws and nuts holding center bow and end panel to frame. Attach hoist chains to corners of housing roof and lift housing as unit, including instrument panel (fig. 9).

12. DISASSEMBLY.

a. Procedure.

(1) Unscrew the elastic stop nuts from the cap screws holding the panel U-type mounting clips (fig. 10) to the support brackets. Remove cap screws and instrument panel. NOTE: These instructions apply to one method of instrument panel attachment. The procedure of actual panel removal will vary with the make of the unit.

(2) Remove the cap screws and nuts attaching the side doors to the housing roof. Remove doors.

(3) Remove nuts and screws holding power receptacles and side panels to center bow, and side panels to end panels. Remove side panels and power receptacles with leads.

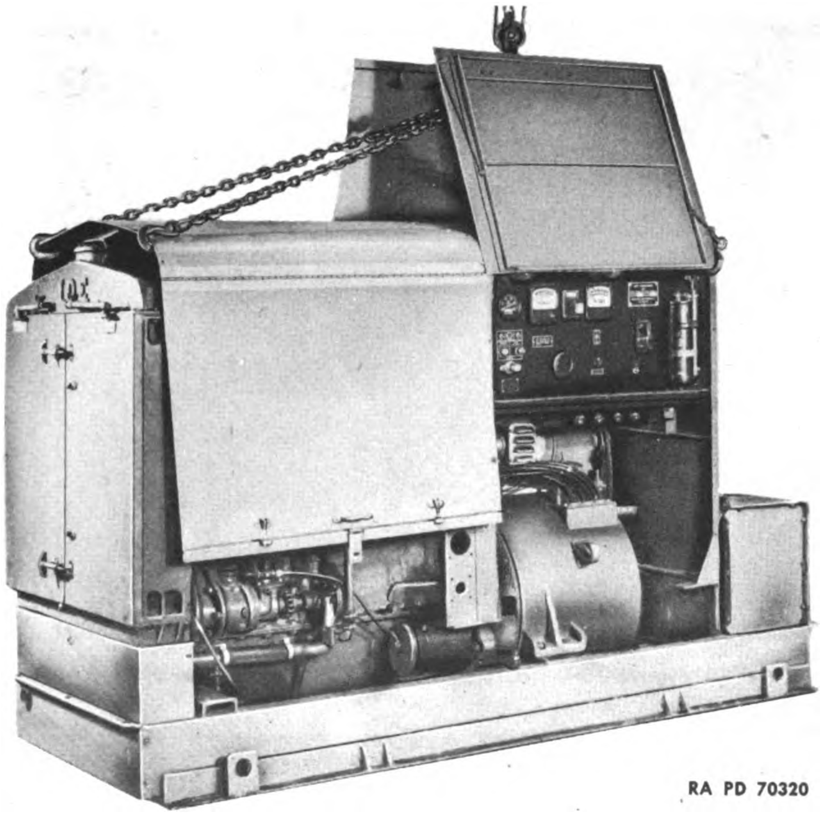

Figure 9 — Housing Removal

(4) Remove the cap screws and nuts holding the roof to the center bow and the end panel, and remove roof.

(5) Remove the cap screws and nuts attaching the gasket tray to the inside of the housing roof. Remove tray.

13. MAINTENANCE AND REPAIR.

a. Procedure.

(1) Hammer out all dents, and straighten any bent sections of housing.

(2) Repair or replace all broken hinges, catches, handles, hasps, etc. Bolt or weld them securely in place.

(3) Weld or repair all broken sections if possible.

(4) Clean up all rusted sections, and remove any loose paint. Clean bare surfaces with SOLVENT, dry-cleaning, and repaint.

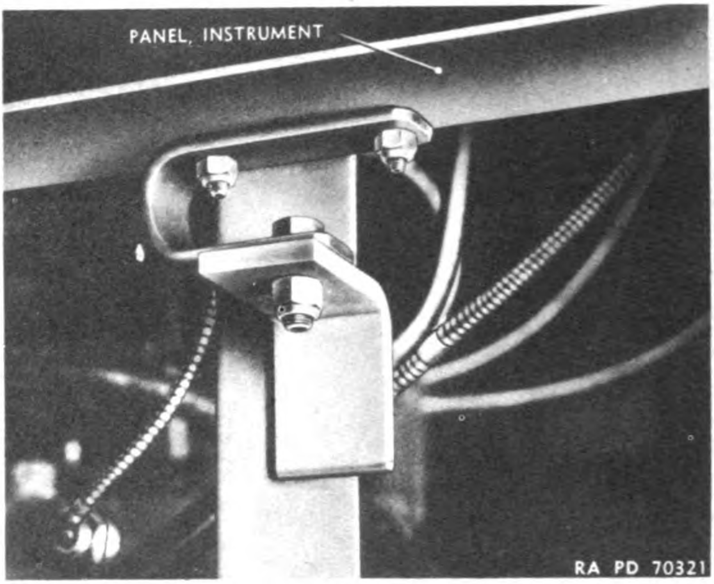

Figure 10 — Instrument Panel Mounting Bracket

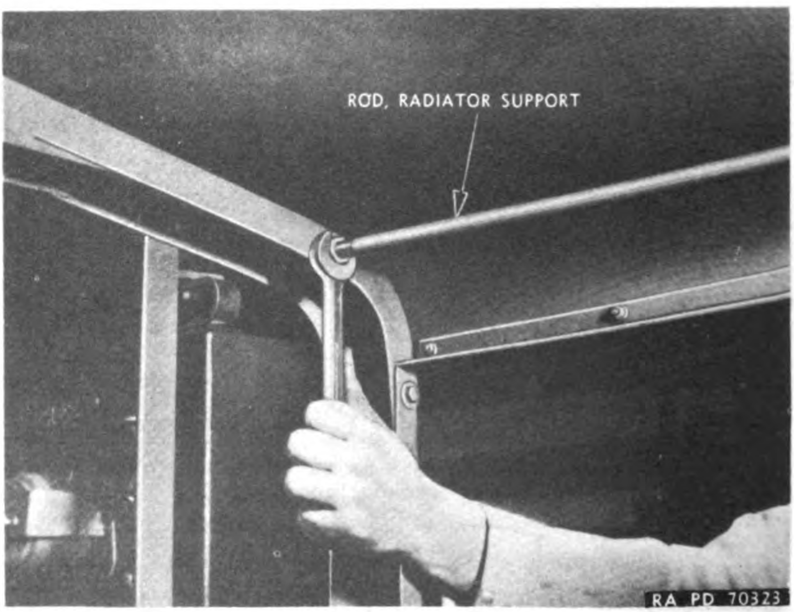

Figure 11 — Radiator Support Rod Installation

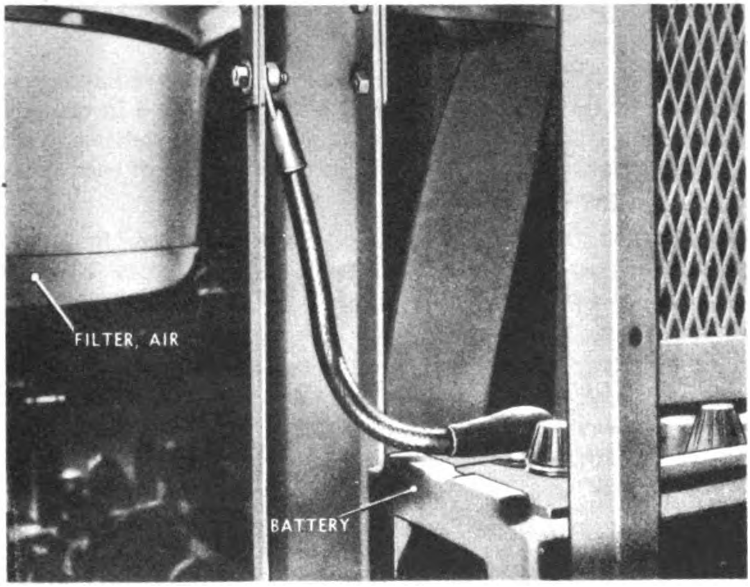

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Figure 12 — Battery Lead Grounded to Housing Support

14. ASSEMBLY.

a. Procedure.

(1) Install gasket tray on the inside of the housing roof plate with cap screws and nuts.

(2) Place center bow and end panel in position to receive roof, and bring roof down in place on bow and end panel. Secure with cap screws and nuts.

(3) Hold each door in place, and secure to roof with cap screws and nuts.

15. INSTALLATION.

a. Procedure.

(1) Attach hoist chains to corners of housing roof, lift housing up, and set down in place on frame (fig. 9). Remove chains and secure center bow and end panel to frame with cap screws and nuts. Secure housing to radiator with cap screws and nuts.

(2) Place side panels in position and attach to frame, center bow, end panel, radiator support panel, and exhaust guard tray with cap screws and nuts. Attach upper lip of panel to angles bolted to cen-

ter bow, with round-head machine screws and nuts. Attach power receptacles with leads to left side panel.

(3) Screw nut on 2⅜-inch threaded end of each radiator support rod. Insert this end of each rod through holes provided in center bow uprights. Bring rods forward to meet tapped holes in radiator. Tighten rods in radiator holes (fig. 11). Put nut on other end of each rod, and tighten nuts against uprights.

(4) Remove nut holding back of brake receptacle housing. Remove nut on post marked "TL," attach lead from post "61" on terminal block, and secure with nut.

(5) Bring fuel tank guard down over fuel tank, at the same time carrying tank hold-down straps down under frame rear panel to holes provided for tank strap end bolts in frame rear cross member. Insert bolts and adjust nuts to hold straps firmly in place. With cap screws and nuts, fasten guard to base. Attach guard to rear panel with cap screws and nuts.

(6) Install instrument panel (par. 109).

(7) Attach tool box to support angles with cap screws and nuts. Attach outer battery tray to angles with cap screws and nuts, and bolt down (fig. 8). Set inside battery tray into outer tray. Set battery in place with negative pole adjacent to center bow (fig. 12). Connect the ground to the center bow with the negative pole of the battery. Remaining lead connects to positive pole. Install battery clamps. NOTE: Some units have negative pole of battery grounded to alternator frame.

CHAPTER 3

ENGINE AND ACCESSORIES

Section I

ENGINE

16. DESCRIPTION.

a. The gasoline engine (figs. 13, 14, and 15) is 6-cylinder, L-head, automotive-type, developing approximately 67 hp at 1,200 rpm. The cylinder block and crankcase are cast in one piece, and the water jacket extends the full length of the cylinder bore. The cylinder head is made of cast iron, and is easily removable to permit service operations.

17. CONSTRUCTION.

a. **Main Bearings.** The main bearings are of the shell-type, babbitt lined, brass back. The use of seven main bearings permits a main bearing being placed on each side of each connecting rod bearing. The center and rear main bearing caps are each held in position by four cap screws, ½ inch in diameter. A removable shell is in each lower cap, as well as in the crankcase. The upper and lower shells are interchangeable. These shells are of the precision-type and are completely finished before being put in place, thus eliminating the need for reaming or scraping. This feature allows easy renewal of bearings.

b. **Pistons.** The pistons (fig. 16) are aluminum, with three compression rings and one oil ring, all located above the piston pin. The piston pins are made of special alloy steel, heat-treated, and accurately ground to size. The pins are clamped in the upper end of the rod, and have a working fit in the piston.

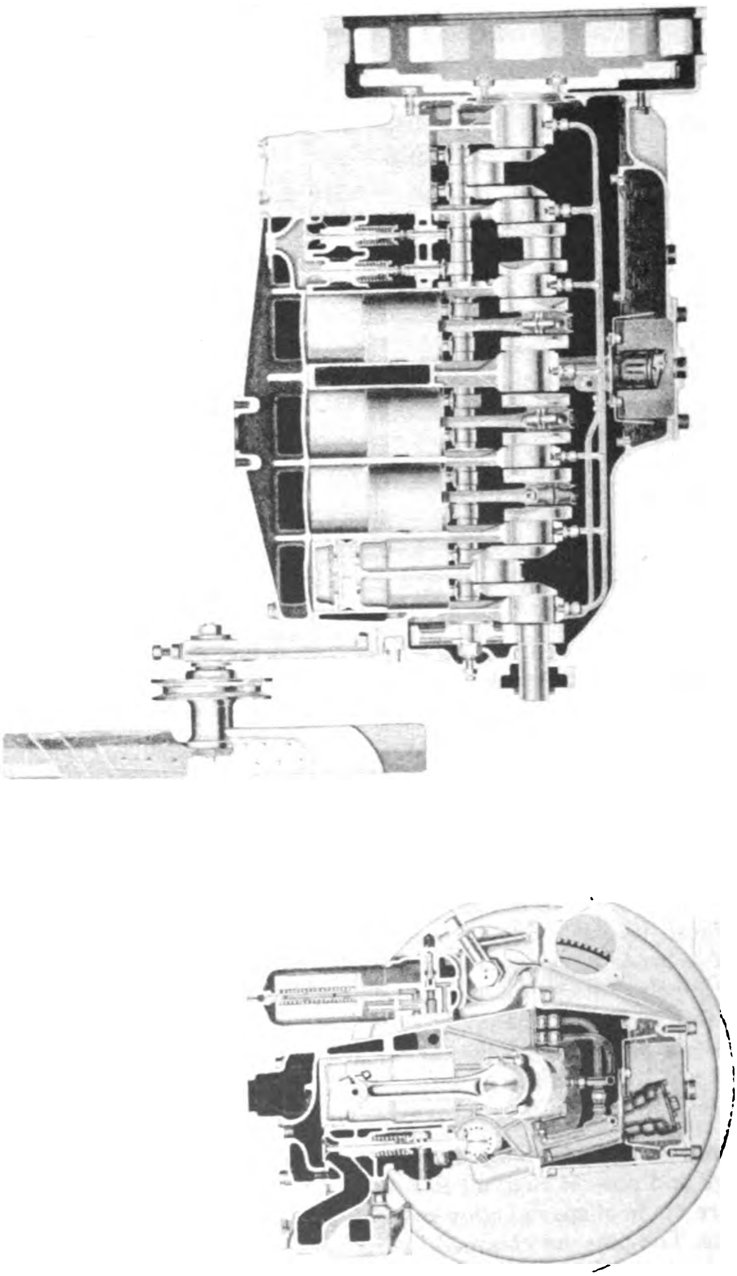

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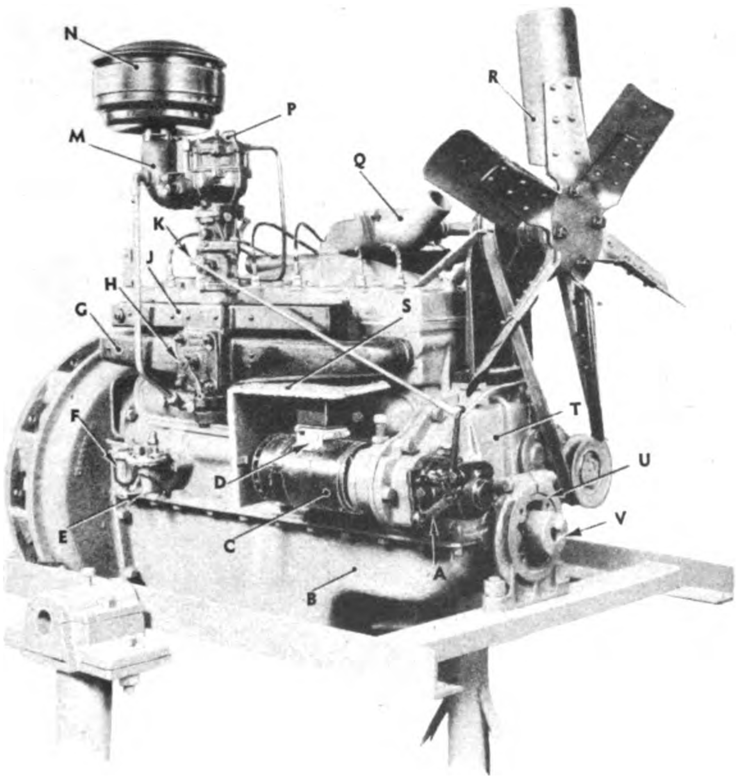
Figure 13 — Engine — Sectional View



A — GOVERNOR
B — PAN, OIL
C — GENERATOR, BATTERY CHARGING
D — REGULATOR, 2-CHARGE
E — PUMP, FUEL
F — BOWL, SEDIMENT
G — MANIFOLD, EXHAUST
H — LEVER, MANIFOLD
J — MANIFOLD, INTAKE
K — BOX, THROTTLE
L — PIPE, BREATHER
M — ELBOW, CARBURETOR
N — FILTER, AIR
P — CARBURETOR
Q — HOUSING, THERMOSTAT
R — FAN
S — BAFFLE, HEAT
T — COVER, GEAR
U — SUPPORT, FRONT ENGINE
V — DOG, CRANKING

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Figure 14 — Engine with Accessories — Right Side

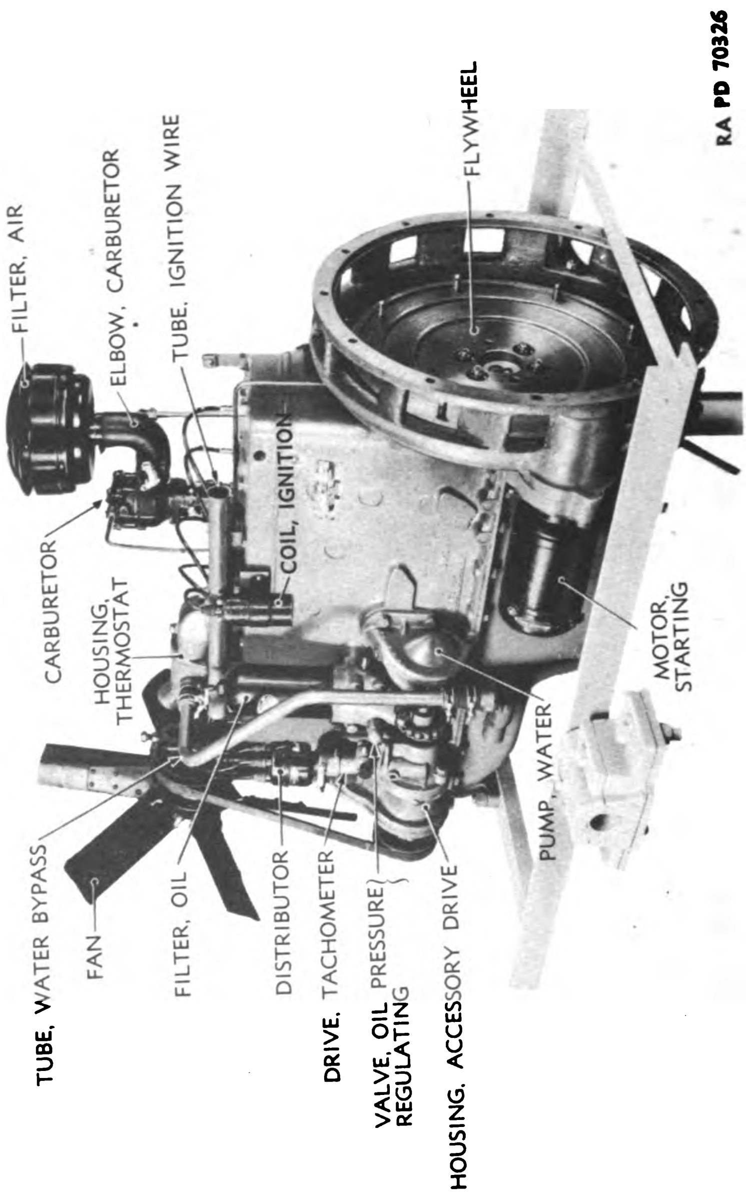

Figure 15 — Engine with Accessories — Left Side

c. **Camshaft and Idler Shaft.** The camshaft is supported on large diameter bearings in the crankcase. These bearings are removable and can be renewed. The idler gear is supported on a shaft which in turn is supported on a bushing pressed into the crankcase. This bushing is also removable and can be renewed.

d. **Valves.** The valve guides are removable bushings pressed into the cylinder block. The valves are forged from special steel. The exhaust valve steel is a special alloy designed to withstand high temperature. Valve tappets are of the mushroom-type, and are guided in removable clusters bolted to the crankcase (fig. 34). Some models of this generating unit have replaceable exhaust valve inserts.

e. **Manifold.** The intake and exhaust manifold (fig. 17) is made of cast iron, and is cast in one piece. The exhaust gases pass through a space which surrounds the intake manifold.

f. **Water Pump Drive.** A water pump drive on the left front corner of the engine is the means of driving the water pump, tachometer, distributor, and fan.

18. SPECIFICATIONS.

Make	Hercules
Model	WXLC-3
Rating	
Bore	4¼ in.
Stroke	4¾ in.
Maximum horsepower at rated speed	67 hp at 1,200 rpm
Piston displacement	404 cu in.
Firing order	1-5-3-6-2-4
Lubrication	Forced feed to all connecting rods and main bearings
Cylinder head	
Type	Detachable
Valve arrangement	L-head
Exhaust port diameter	1½ in.
Intake port diameter	1⅝ in.
Pistons	
Material	Aluminum
Rings above pin	4
Rings below pin	0
Number oil rings	1
Number compression rings	3
Oil ring width	$\frac{3}{16}$ in.
Compression ring width	⅛ in.

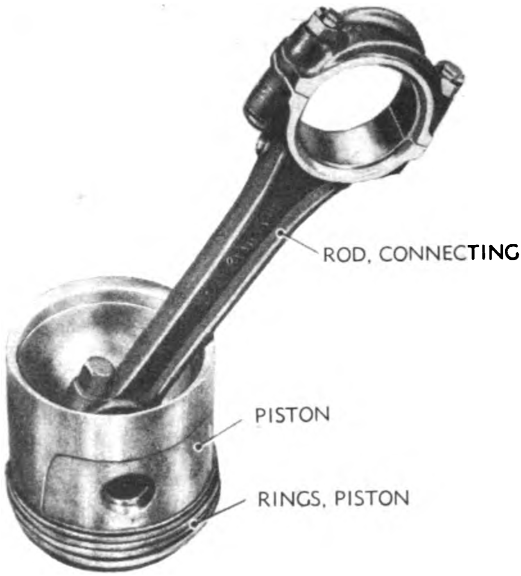

Figure 16 — Piston, Connecting Rod, and Bearing

Figure 17 — Manifold, Companion Flange, and Gaskets

Piston pin	
Diameter	1⅛ in.
Number bearings per piston	2
Bearing location	In piston
Bearing length	1½ in. each
Crankshaft	
Number bearings	7
Bearing diameter	2⅝ in.
Bearing length (front)	1¾ in.
Bearing length (center)	2¾ in.
Bearing length (others)	1½ in.
Camshaft	
Drive	Helical gear
Location	Right side of cylinder block
Number bearings	4
Bearing diameter	2⅛ in.
Bearing length (front)	1$^5/_{16}$ in.
Bearing length (center, 2)	⅞ in.
Bearing length (rear)	1⅜ in.
Connecting rods	
Bearing diameter	2¼ in.
Bearing length	1⅛ in.
Connecting rod length (center to center)	9 in.
Carburetor	
Size	1⅝ in. SAE
Adjustment	Idling speed only
Cooling	Water pump
Generator	
Mounting	Right side of engine, behind governor
Drive	From timing gear
Starting motor mounting	Standard SAE mount on bellhousing
Spark plug size	⅞ in. thread, $^{15}/_{16}$ in. nut
Exhaust manifold bore	2½ in.

19. TROUBLE SHOOTING.

a. Engine Skips or Misses.

Possible Cause	Possible Remedy
Spark plugs cracked or dirty.	Clean or replace plugs.
High tension wires broken or shorted.	Replace wires. Find short, and remedy.
Distributor cap or rotor broken, damp, or dirty.	Service or replace cap or rotor.

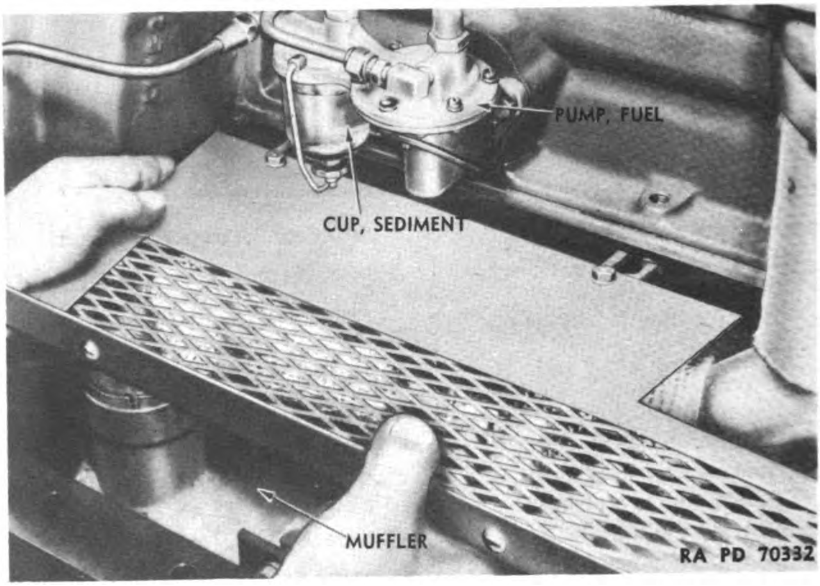

Figure 18 — Exhaust Guard Tray Removal

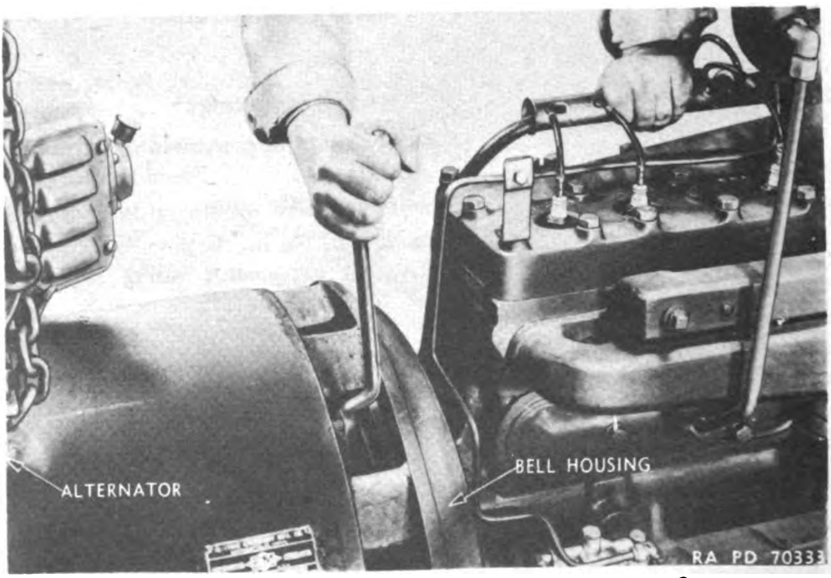

Figure 19 — Removing Alternator — Bell Housing Screws

Possible Cause	Possible Remedy
Faulty distributor points, condenser, or coil.	Replace points, condenser, or coil.
Valves adjusted to close, or badly worn guides.	Adjust valves, or replace guides.
Leaking head gasket.	Replace gasket.
Cracked water jacket.	Weld crack, or replace jacket.
Improperly adjusted carburetor.	Adjust carburetor correctly.
Air leak in intake manifold or head.	Discover leak, and correct.
Partially plugged gas line.	Blow out line.

b. Lack of Power in Engine.

Skipping engine.	Check ignition system (chapter 3, section VII).
Engine out of time.	Retime (par. 27a (9)).
Needs carbon removed and valves ground.	Remove carbon and grind valves (par. 23 d).
Low or uneven compression.	See paragraph 27 a (2).
Engine overheats.	See paragraph 29 a.
Mixture too rich.	Adjust carburetor idling screw for leaner mixture.

c. Engine Vibrates.

Mountings loose.	Tighten mountings.
Bad skip in engine.	Check ignition system (section VII).
Ignition and timing too far advanced.	Retard distributor.
Mixture too rich.	Adjust carburetor idling screw for leaner mixture.

d. Engine Overheats.

Circulation plugged in radiator forming cold spot in core.	Clean out radiator.
Radiator block dirty.	Clean out radiator.
Ignition late.	Advance distributor.
Fan belt slipping.	Tighten belt by belt adjusting screw.
Thermostat stuck closed.	Service or replace thermostat.

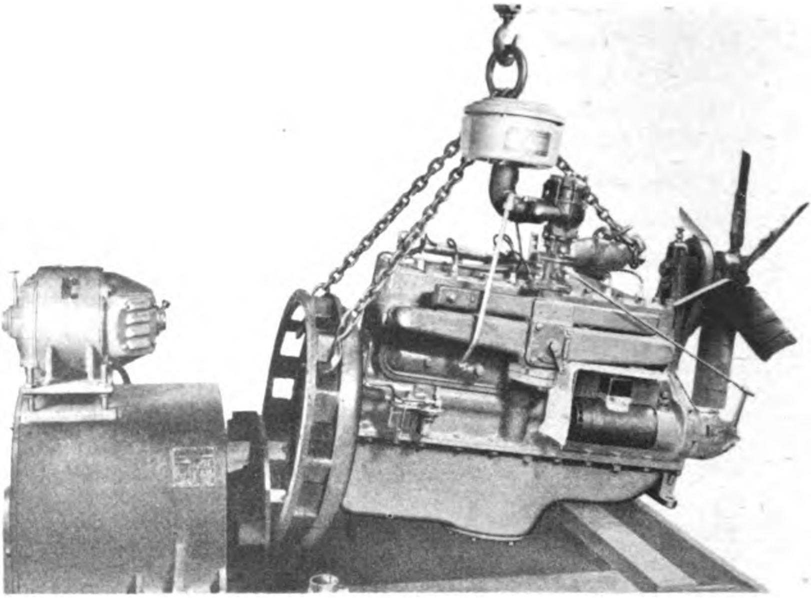

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Figure 20 — Removing Engine from Frame

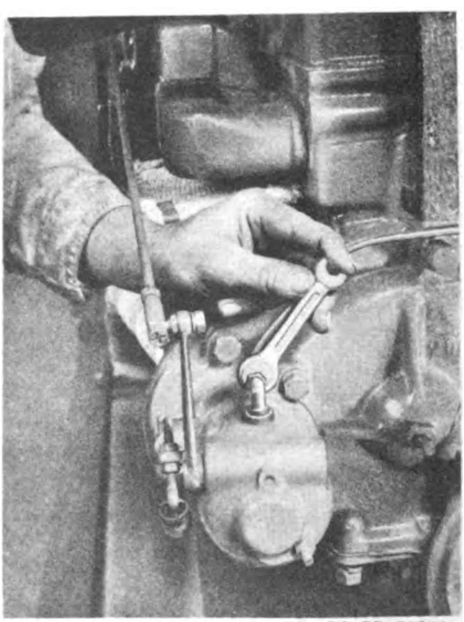

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Figure 21 — Disconnecting Governor Lubrication Fitting

e. Engine Knocks.

Possible Cause	Possible Remedy
Carbon deposit in head.	Remove carbon.
Spark advanced too far.	Correct timing (par. 27 a (9)).
Governor weights stuck or springs weak.	Service or adjust governor (par. 50).
Loose wristpins.	Renew wristpins.
Connecting rod out of alinement.	Aline or replace.
Loose rod bearings.	Replace bearings.
Loose main bearings.	Replace bearings.
End play in camshaft.	Tighten end play adjusting screw so as to barely feel shaft, then back off not more than one-quarter turn.
Loose tappets.	Adjust tappets.
Sticky valve stems.	Clean stems with kerosene or dry-cleaning solvent.
Loose spark plugs.	Tighten plugs.
Flywheel loose.	Tighten flywheel attaching bolts.

f. Grinding or Scraping Noise in Engine.

Generator bearings worn.	Replace bearings.
Water pump bearings bad.	Replace bearings.
Broken ring or piston.	Replace ring or piston.

g. Engine Uses Too Much Oil.

Piston ring gaps lined up.	Turn rings.
Piston rings worn or carbon in ring grooves.	Replace rings or remove carbon.
Vacuum pump diaphragm cracked or porous.	Replace diaphragm.
Rod or main bearings have too much clearance.	Shim up for proper clearance (par. 24 a (4) and 24 a (13)).

h. Excessive Gas Consumption.

Worn out spark plugs.	Replace spark plugs.
Timing late.	Retime engine.

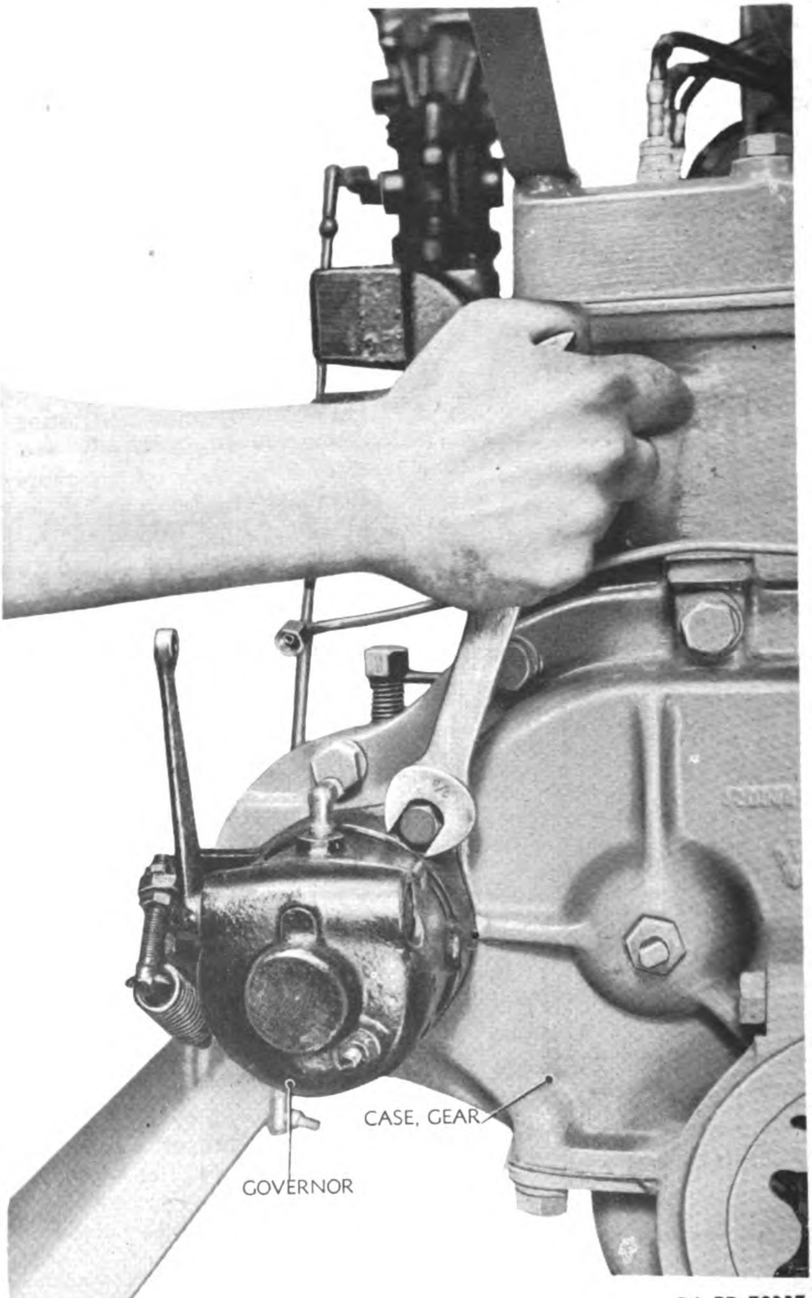


Figure 22 — Governor Removal

Possible Cause	Possible Remedy
Carburetor dirty, and out of adjustment.	Clean and adjust carburetor.
Engine idles too fast.	Adjust governor (par. 50).
Choke out of adjustment.	Adjust choke.
Air cleaner dirty or too full of oil.	Service cleaner.

i. Engine Fails To Start.

Fuel system clogged or fuel supply exhausted.	Blow out fuel lines or renew fuel supply.
Defective fuel pump.	Repair or replace pump.
No spark at spark plugs.	See chapter 3, section VII.

j. Generator Fails To Charge.

Voltage regulator out of order.	Repair or replace.
Generator not operating properly.	Repair or replace.
Poor connections in circuit.	Tighten connections.

20. REMOVAL.

a. Procedure.

(1) Remove housing (par. 11).

(2) Drain water from cooling system by opening drain cock in radiator outlet pipe.

(3) Loosen metal straps binding two hose sections in upper radiator water line and one hose section in lower radiator line by loosening bolts. Work off hose sections.

(4) Disconnect the fan guard sections by removing the attaching bolts and nuts. Take off square nuts holding the two guard sections to the housing, and remove guard.

(5) Free radiator from frame by taking out four cap screws holding radiator to frame. Remove radiator.

(6) Close shut-off cock on fuel line (fig. 83). Uncouple nut on engine side of cock and disconnect line. Remove fuel tank (par. 36 b).

(7) Loosen the four cap screws attaching expanded metal exhaust guard tray to tabs, and remove tray (fig. 18).

(8) Disconnect flare tube fitting in fuel pump inlet line. Remove line.

(9) Loosen manifold flange retaining bolt. Remove exhaust pipe from manifold flanges.

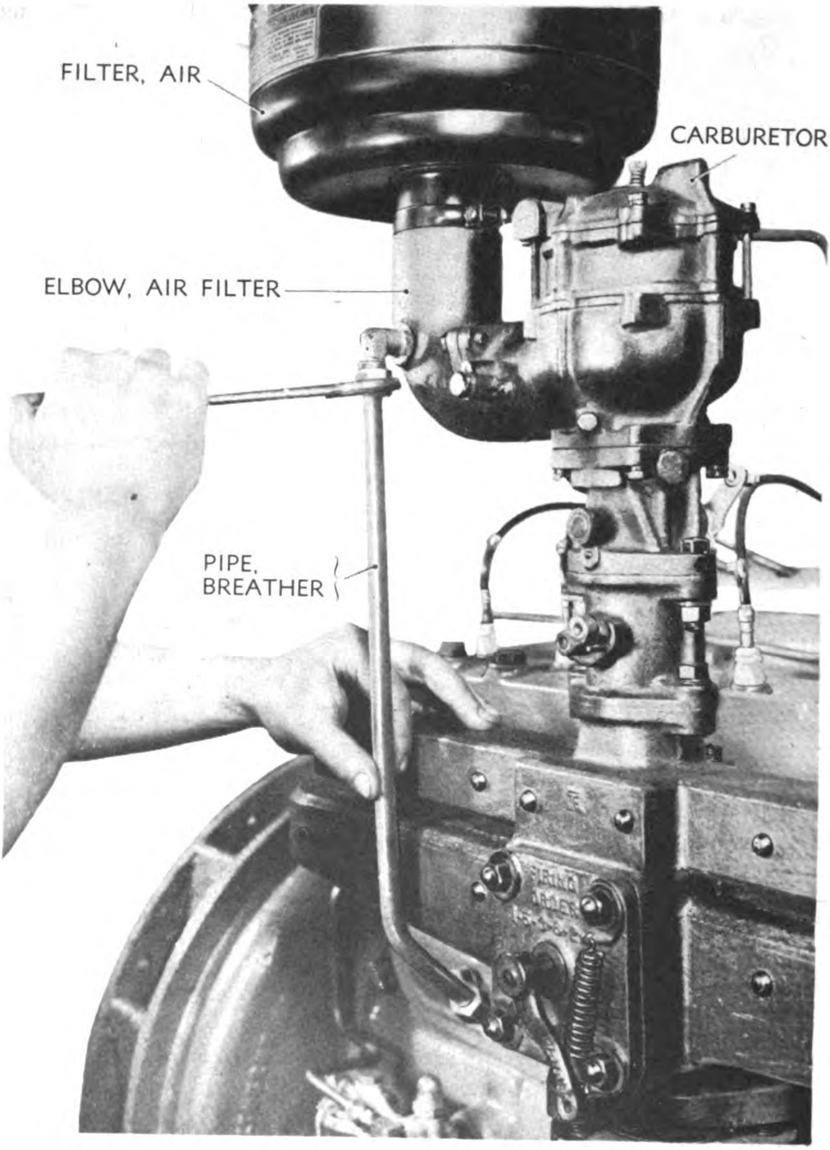


Figure 23 — Breather Tube Removal

(10) Take out screws attaching expanded metal guard to bell housing.

(11) Take out the eight cap screws attaching bell housing to alternator housing (fig. 19). Remove wires tying flywheel coupling bolts together. Remove castellated nuts from these bolts.

(12) Remove engine support cap screws. Adjust hoist chains about engine (fig. 20). Bring engine forward and then up from frame. Be sure engine is clear of alternator before lifting.

21. REMOVAL OF ACCESSORIES.

a. **Procedure.** For additional information on removal of accessories, see TM 9-618.

(1) Remove fan belt.

(2) Remove fan and bracket.

(3) Loosen nut holding lubricating oil line to the compression ell at the top of the governor (fig. 21). Hold hexagonal section of ball pin linkage joint at governor. Remove nut, and disconnect linkage from governor. Take out cap screws holding governor to engine (fig. 22), and remove governor.

(4) Remove battery-charging generator.

(5) Remove breather tube (fig. 23), after disengaging nuts at each end of tube.

(6) Disconnect fuel line by disengaging flare tube fitting at back of carburetor. Remove air cleaner, carburetor, and throttle box from engine as a unit, by taking out cap screws holding throttle box to upper manifold flange.

(7) Disconnect fuel line connection at fuel pump, by loosening flare tube fitting nut. Take out the two cap screws that hold fuel pump to engine and remove pump.

(8) Remove manifold.

(9) Remove starting motor.

(10) Unscrew machine bolts from clamps holding hose sections at top and bottom of bypass, and work bypass pipe out of the hose sections.

(11) Take out the two cap screws connecting the thermostat housing to the engine head, and remove housing (fig. 24).

(12) Remove oil filter (fig. 25).

(13) Remove ignition leads and ignition coil.

(14) Loosen vertical cap screw in arm below distributor, and loosen horizontal bolt at right (fig. 26). Loosen iron collar below clamp, and remove distributor (fig. 27).

(15) Take out cap screw and nut connecting tachometer drive flange to accessory drive housing flange. Raise and remove tachom-

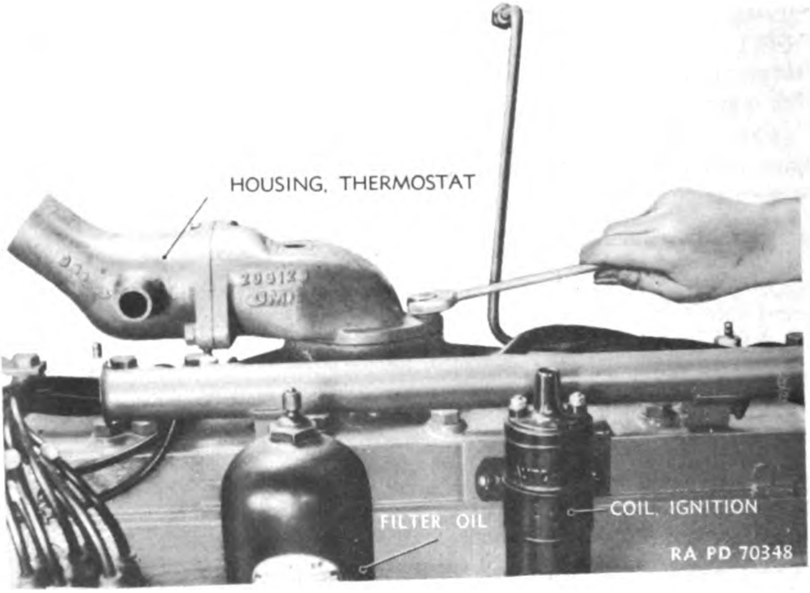


Figure 24 — Thermostat Housing Removal

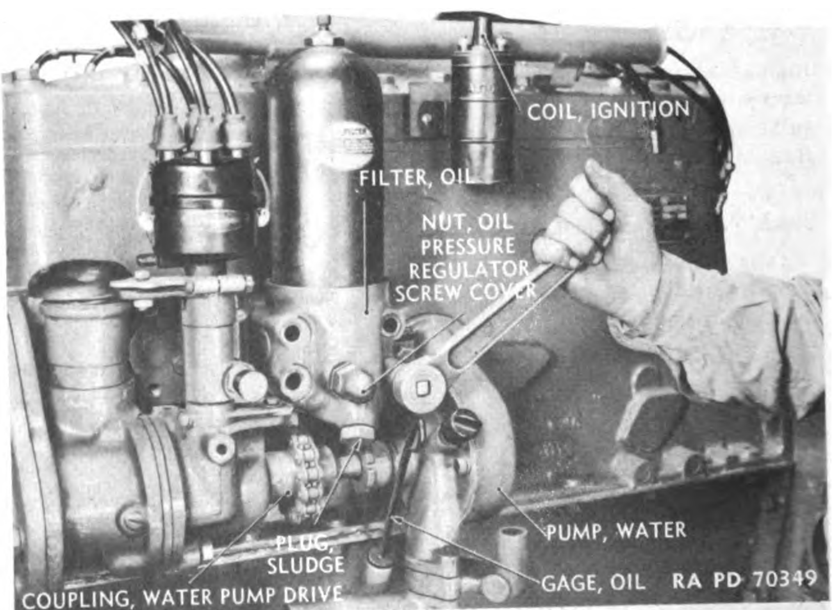


Figure 25 — Oil Filter Base Removal

eter drive. NOTE: On units which substitute a frequency meter for a tachometer, a gear on the distributor shaft directly engages the accessory drive.

(16) Remove water pump.

22. DISASSEMBLY.

a. Procedure.

(1) Pull out cotter pins holding fan belt pulley drift pin in place. Knock out drift pin through pulley and drive shaft (fig. 28). Remove pulley.

(2) Knock out key from accessory drive shaft (fig. 29). Remove cap screws attaching drive housing (fig. 30), and remove housing and drive.

(3) Loosen the lubricating oil filler pipe by holding a wood block against the lower lip and tapping block with hammer (fig. 31). Remove pipe.

(4) Remove spark plugs.

(5) Take out the cap screws attaching the cylinder head to the block (fig. 32), and remove head (fig. 33).

(6) Insert valve spring lifter between valve spring seat and valve tappet cluster casting, compress spring, and lock lifter. Remove valve spring seat pin (fig. 35). Push valve through engine block and remove. Repeat for each valve. Keep valves in proper order after removal to insure the return of each valve to its former position.

(7) Compress valve spring as much as possible with lifter. Insert screwdriver to hold valve spring under tension. Slide out lifter. Force valve spring and valve seat out of chamber with screwdriver (fig. 36). Repeat for each valve spring.

(8) Take out cap screws attaching tappet clusters to engine block (fig. 37), and remove clusters (fig. 38).

(9) Drain crankcase by opening draincock in bottom of oil pan. Take out cap screws holding pan to block and bell housing, and remove pan and gasket (fig. 39).

(10) Disconnect oil line to oil pump by unscrewing flare tube fitting nut. Take out four cap screws holding pump bracket in place, and remove oil pump (fig. 40).

(11) Take out oil lines connecting oil pump to lubrication points by loosening the flare tube fitting and disconnecting the lines (fig. 41).

(12) Take cotter pins from castellated nuts on cap screws holding connecting rod bearing caps in place. Remove nuts (fig. 42), and push cap screws out. Force connecting rod and piston up through engine block (fig. 43). NOTE: Rejoin the connecting rod bearing cap

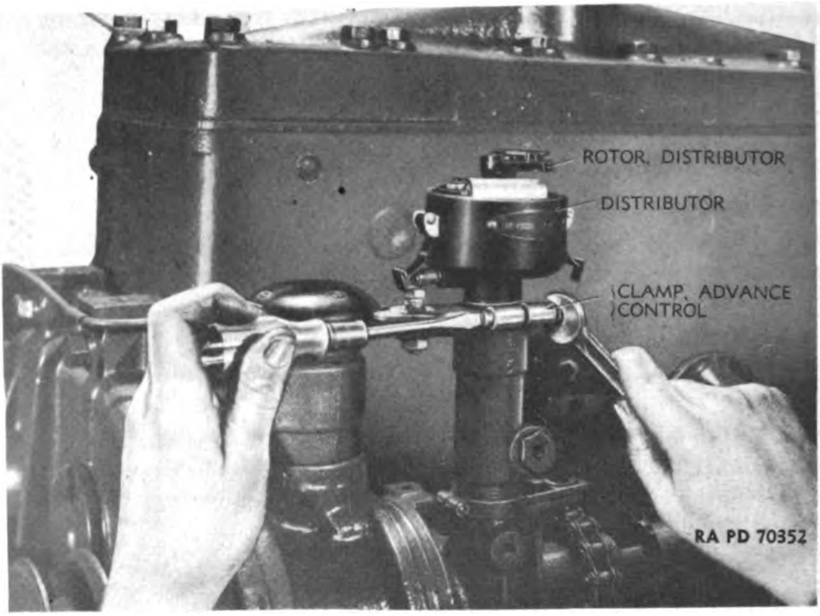
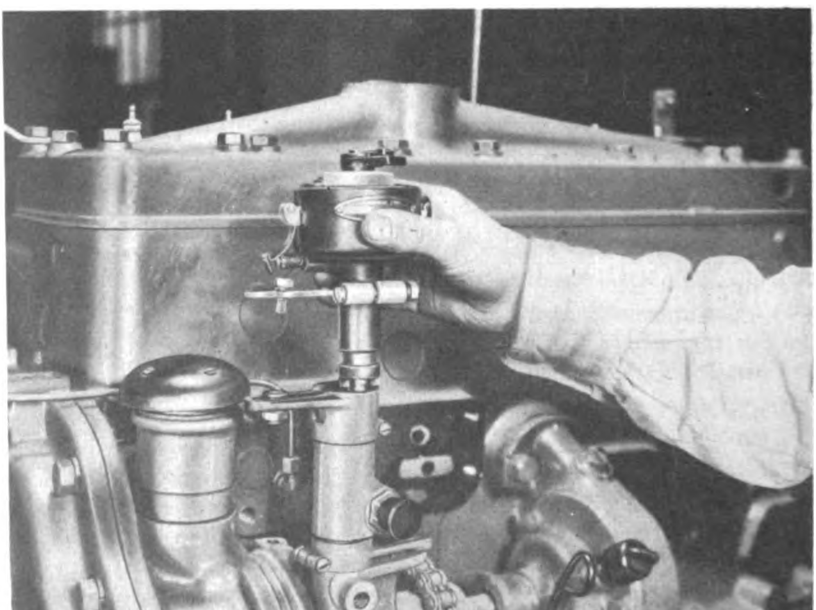


Figure 26 — Removing Distributor Screws



RA PD 70353

Figure 27 — Distributor Removal

to the proper connecting rod and piston before laying aside. The correct pistons and caps are labeled identically.

(13) Loosen horizontal cap screw at top of front engine support (fig. 44). If hold-down bolts have been used, remove them, and then slide support out (fig. 45).

(14) Loosen set screw holding drift pin through cranking dog and shaft. Remove drift pin and cranking dog.

(15) Take out cap screws attaching gear cover to engine block (fig. 46), and remove cover (figs. 47 and 48).

(16) Pull off oil retainer ring and gasket from the crankshaft.

(17) Pull out idler gear and shaft (fig. 49).

(18) Slide out camshaft with gear still attached. While one man pulls the shaft, another should guide the shaft carefully through the bearings, so that the cams will not injure babbitt linings (fig. 50).

(19) Take out cotter pins securing castellated nuts to crankshaft flywheel studs (fig. 51). Remove castellated nuts (fig. 52), and work off flywheel (fig. 53).

(20) Take out wires through pairs of crankshaft bearing cap screw heads. Take out cap screws (fig. 54) and remove bearings, lower shells, and shims. Mark back of each shell with number corresponding to that on its cap, so that at assembly correct shell will be used with each cap, if no new shell is required.

(21) Carefully pry out brass thrust bearing sections from between end flange of flywheel and engine block (fig. 55).

(22) Take out cap screws holding bell housing to engine block (figs. 56 and 57). Remove bell housing. (fig. 58).

(23) Lift crankshaft out of position and away from engine block.

(24) Remove upper bearing shells by pushing down with the hands on one end of each shell until it rotates in bearing web enough to get fingers under shell. Then lift out shell (fig. 59). Mark for correct replacement.

23. MAINTENANCE AND REPAIRS.

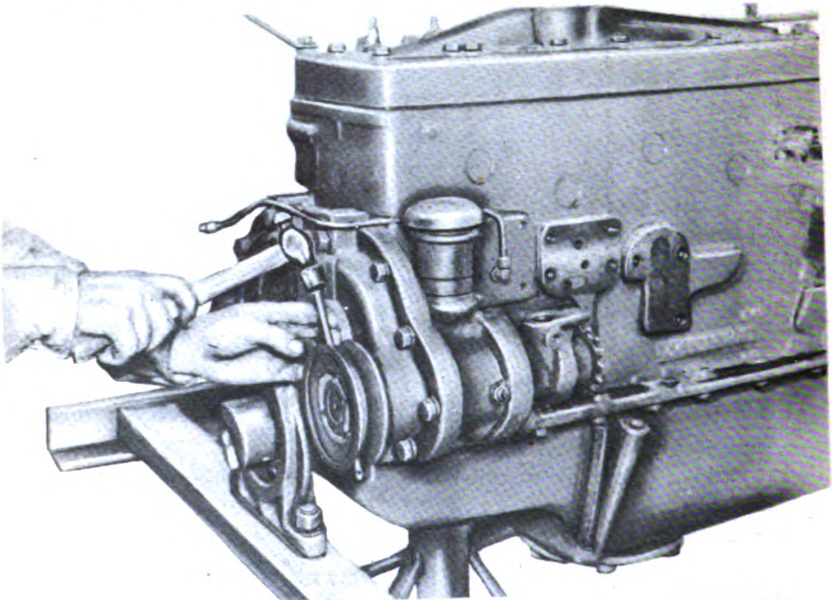
a. Cleaning Engine Parts.

(1) Before inspection, all parts should be thoroughly cleaned of oil, grease, or carbon. Methods of cleaning are given below.

(a) Soak all aluminum parts overnight in SOLVENT, dry-cleaning, and dry.

(b) Clean the aluminum pistons as above. Clean the ring grooves with a broken piston ring ground flat on the end.

(c) Place all steel parts in SOLVENT, dry-cleaning. Leave them only long enough to dissolve all grease and dirt. Remove the parts,



RA PD 70357

Figure 28 — Driving Out Pulley Pin

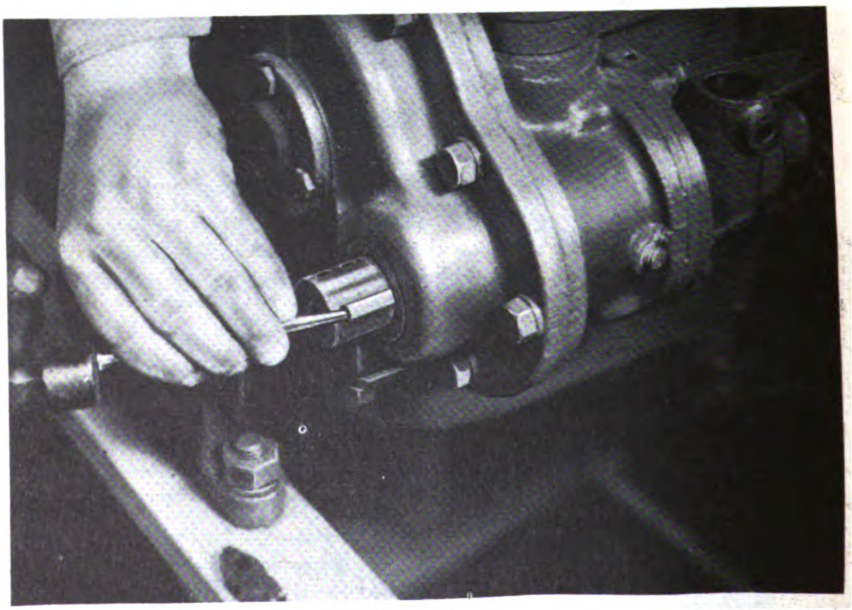


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Figure 29 — Driving Out Accessory Drive Shaft Key

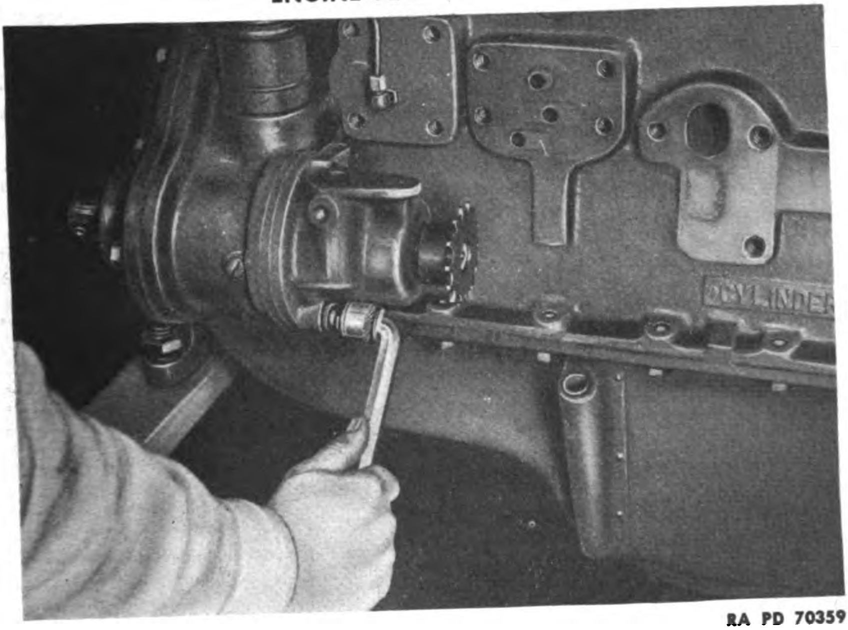

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Figure 30 — Accessory Drive Housing Removal

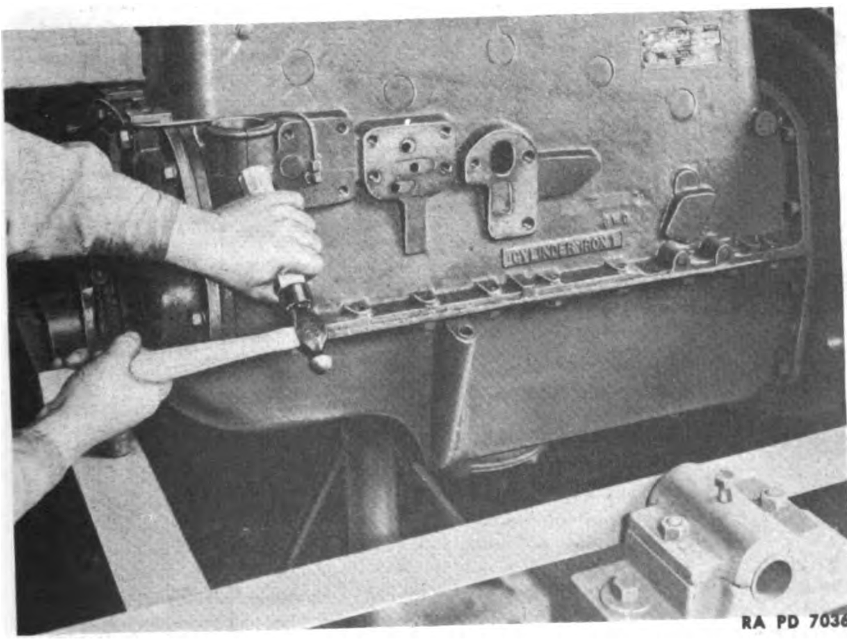

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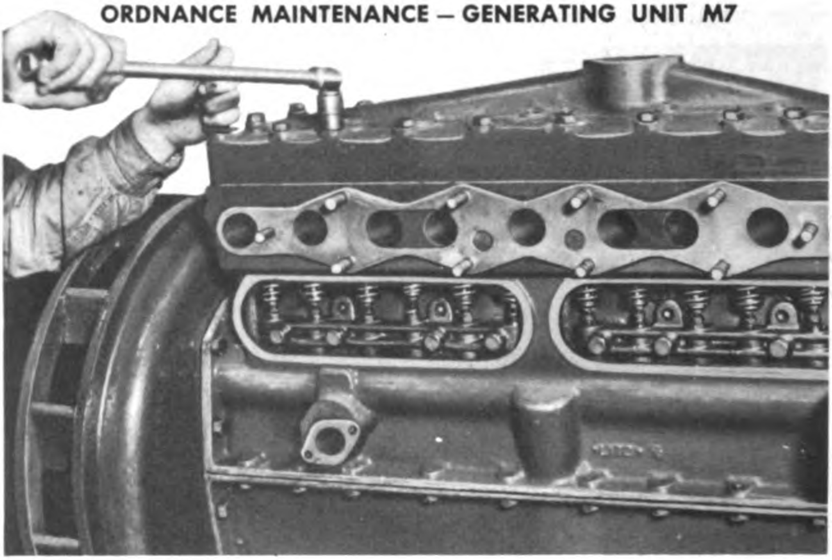
Figure 31 — Driving Out Lubricating Oil Filler Pipe



RA PD 70362

Figure 32 — Removing Cylinder Head Cap Screws

rinse in hot water, blow out with compressed air from an air hose, and wipe dry.

(d) Cylinder block and crankshaft oil passages should be cleaned thoroughly by forcing steam through each opening until it flows without restriction.

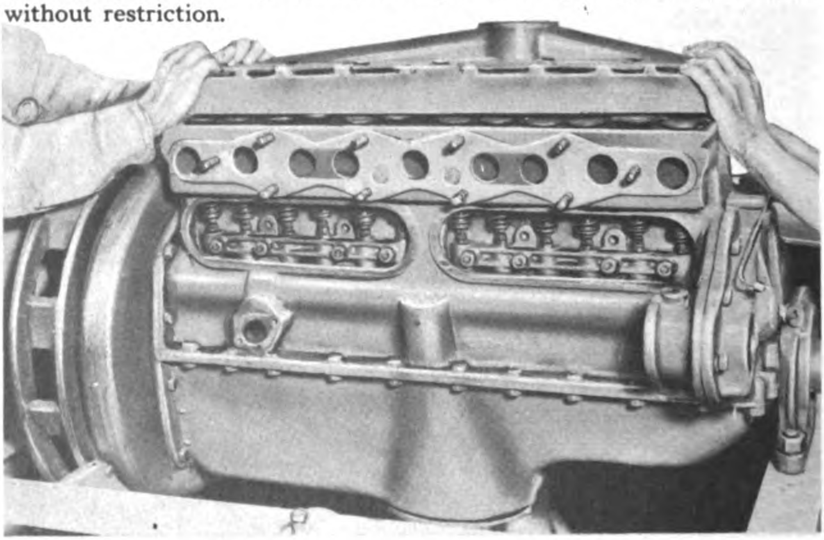


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Figure 33 — Cylinder Head Removal

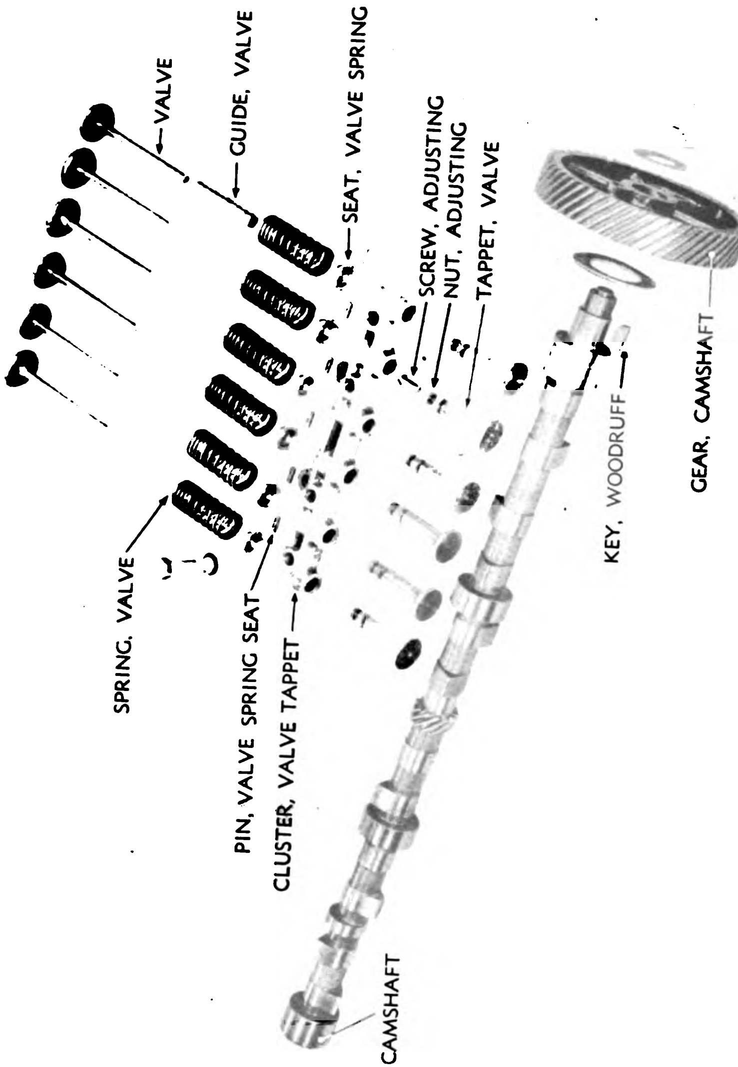

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Figure 34 — Relation of Camshaft to Valve Tappets, Springs, Guides, and Valves

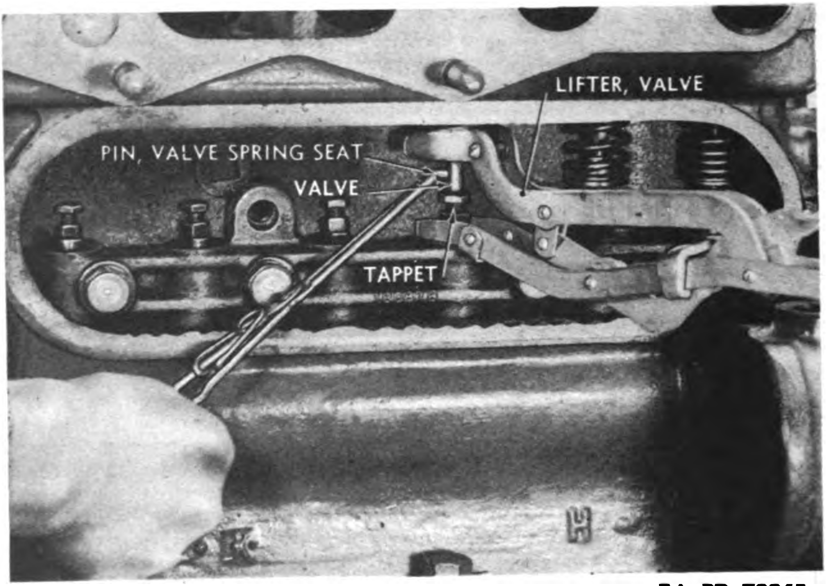

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Figure 35 — Valve Spring Seat Pin Removal

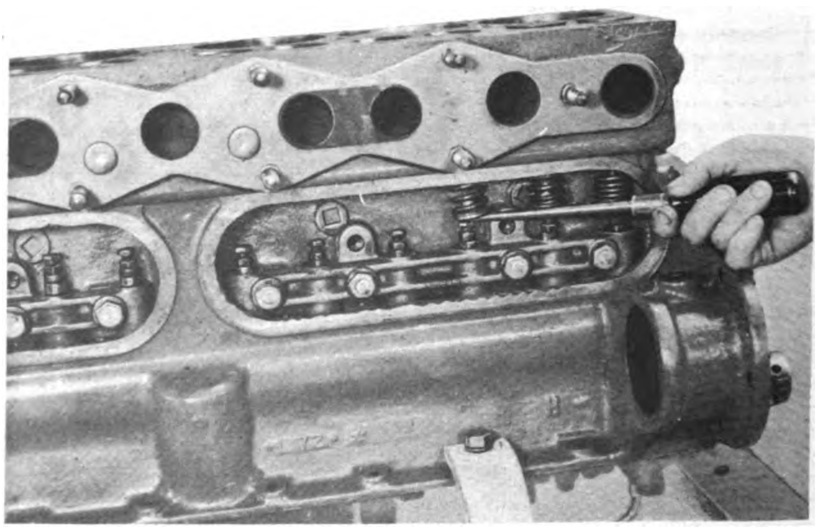

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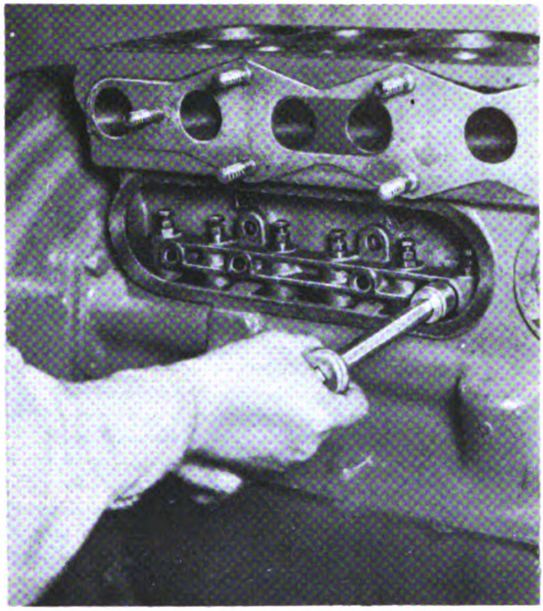
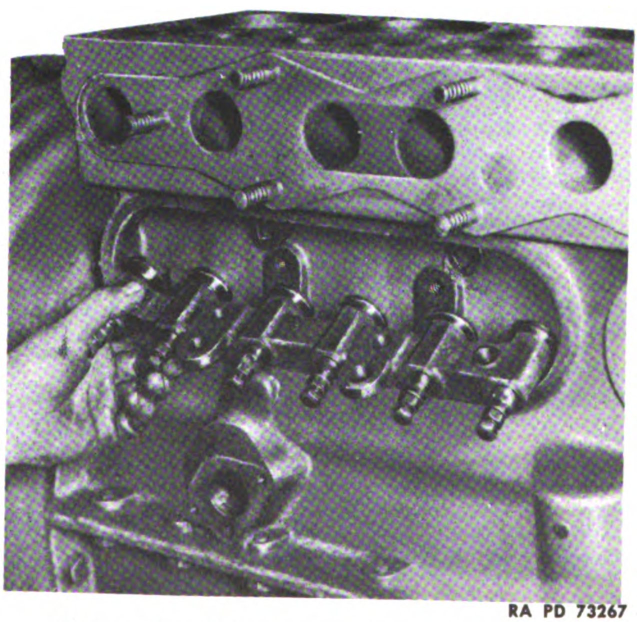
Figure 36 — Valve Spring Removal

(e) Strip off all gaskets and clean all surfaces where sealing compound has been used, by scraping and washing with a suitable solvent.



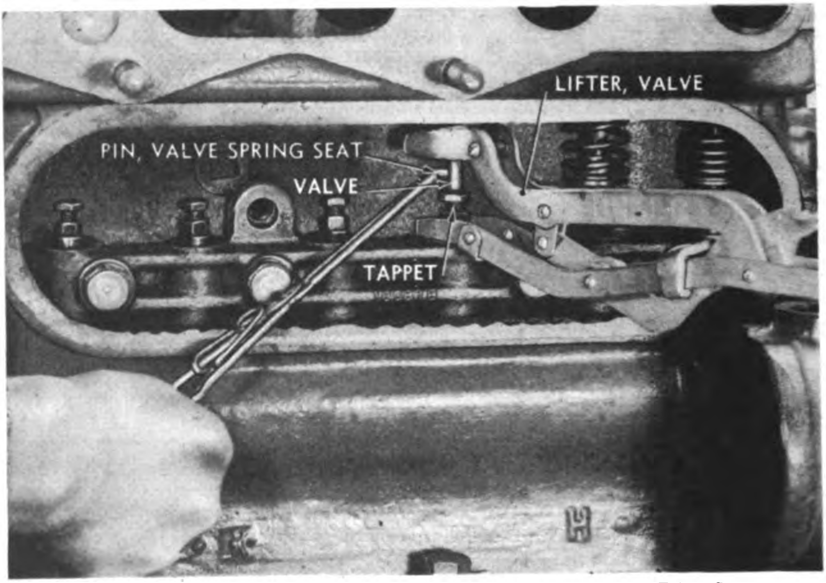
RA PD 73266

Figure 37 — Removing Valve Tappet Cluster Holding Cap Screw



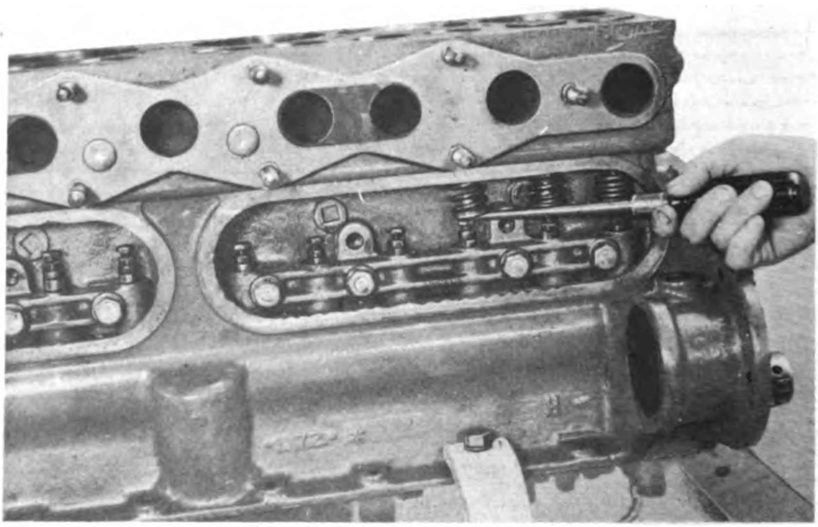
RA PD 73267

Figure 38 — Valve Tappet Cluster Removal



RA PD 70365

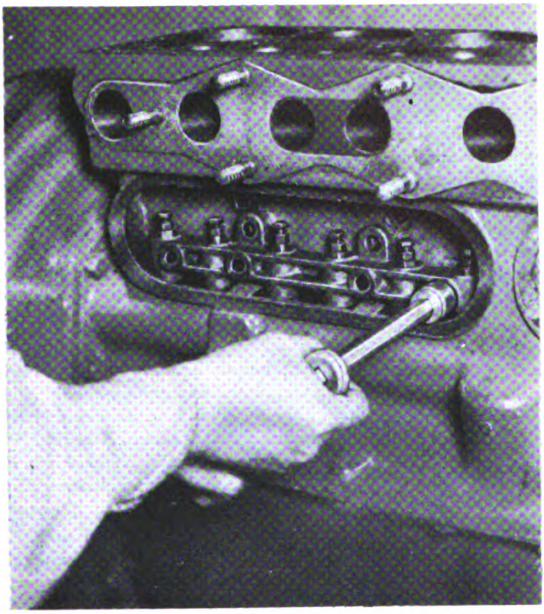
Figure 35 — Valve Spring Seat Pin Removal



RA PD 70366

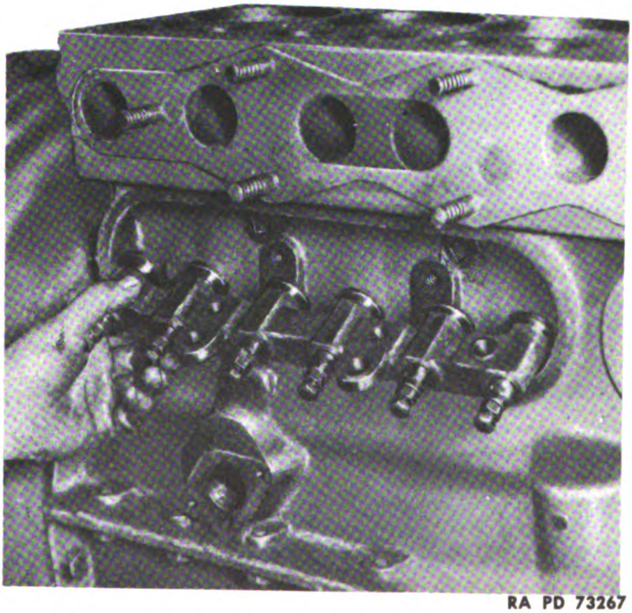
Figure 36 — Valve Spring Removal

(e) Strip off all gaskets and clean all surfaces where sealing compound has been used, by scraping and washing with a suitable solvent.



RA PD 73266

Figure 37 — Removing Valve Tappet Cluster Holding Cap Screw



RA PD 73267

Figure 38 — Valve Tappet Cluster Removal

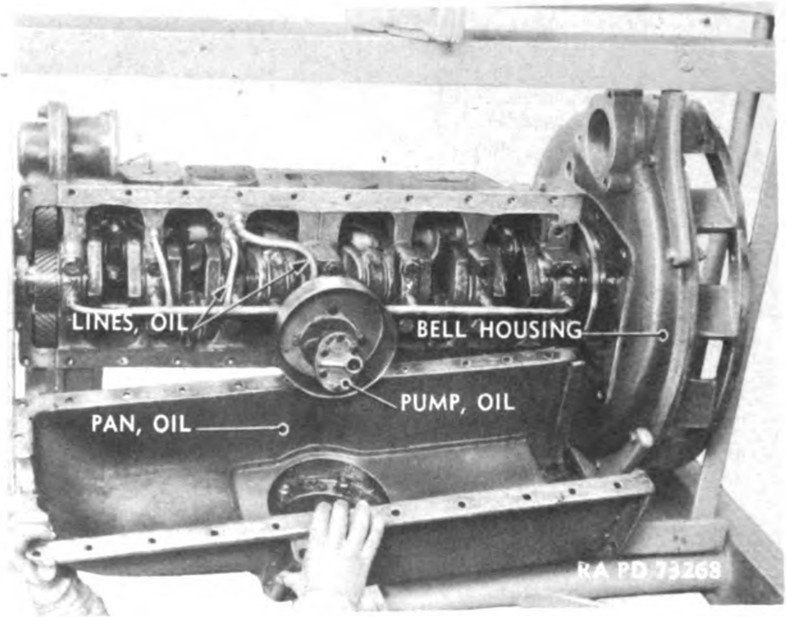
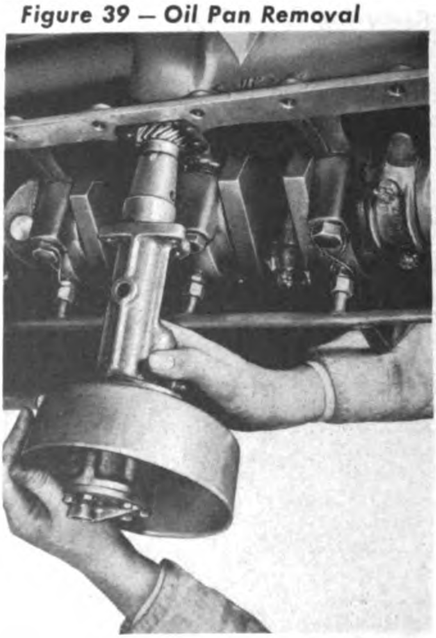
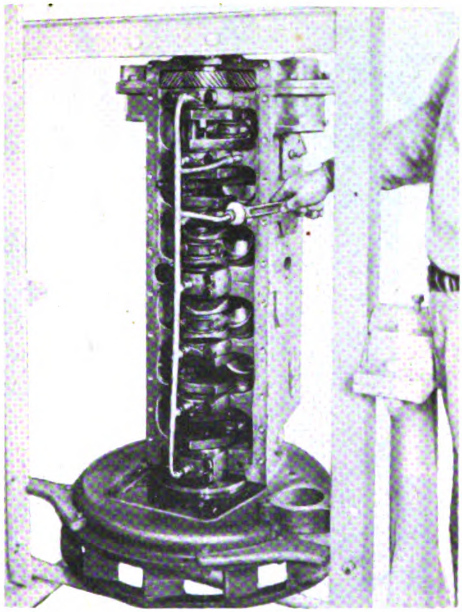


Figure 39 — Oil Pan Removal



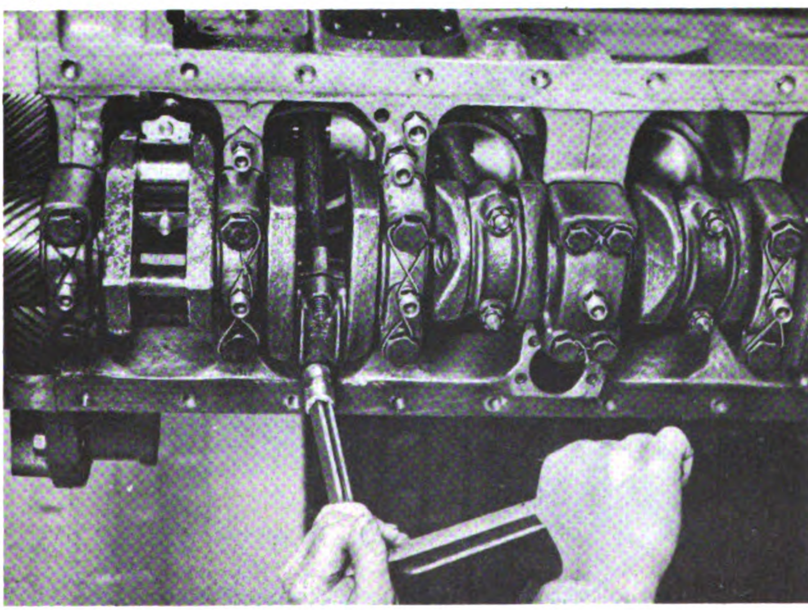
RA PD 56961

Figure 40 — Oil Pump Removal



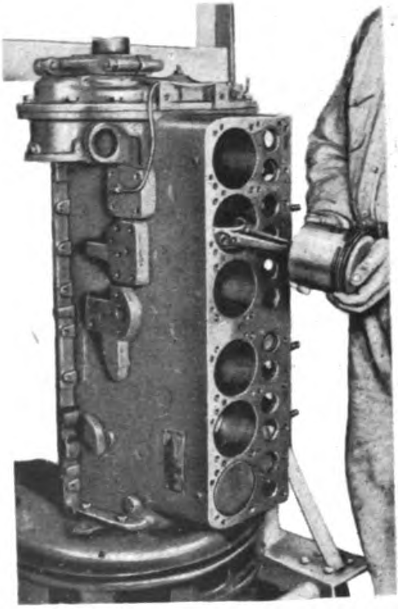
RA PD 73270

Figure 41 — Oil Line Removal



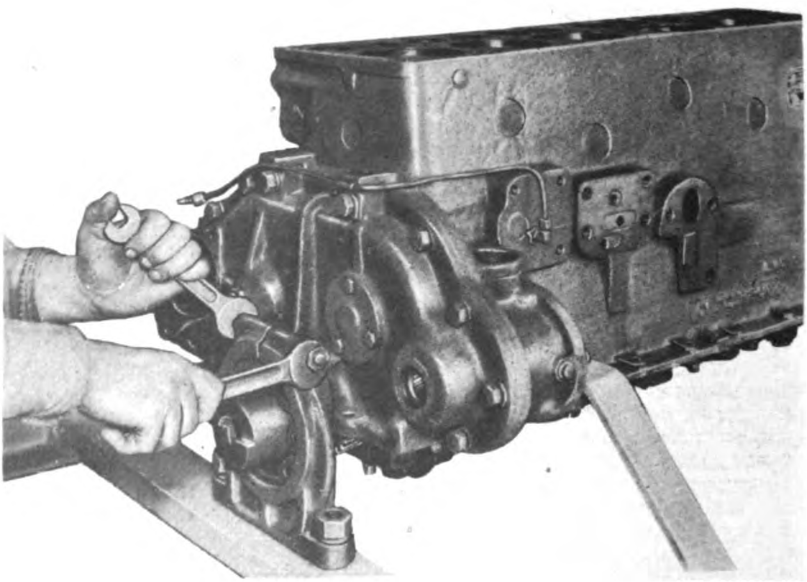
RA PD 73273

Figure 42 — Connecting Rod Bearing Cap Removal



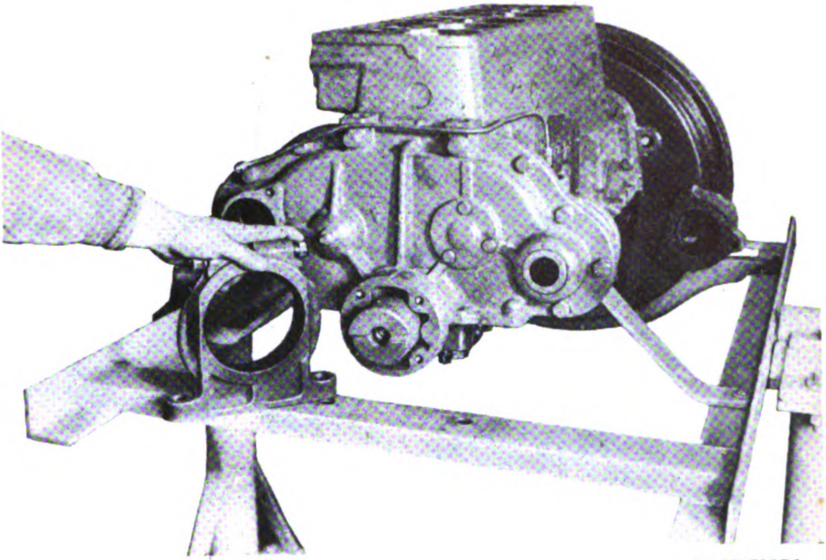
RA PD 73274

Figure 43 — Piston Removal



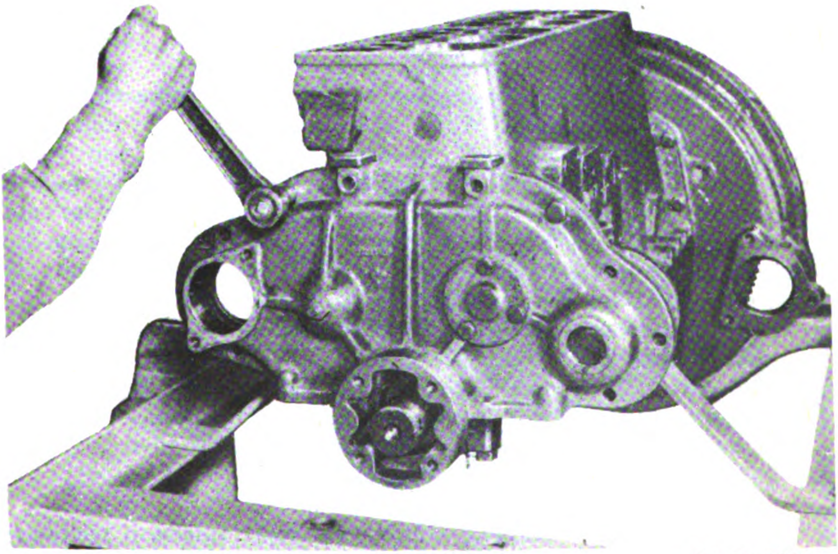
RA PD 73275

Figure 44 — Front Engine Support Removal



RA PD 73276

Figure 45 — Front Engine Support Removed



RA PD 73277

Figure 46 — Gear Cover Removal

b. **Inspecting Engine Parts.** After parts are cleaned, each part should be inspected and then covered to protect it from dust and dirt, etc., if it is to be used for reassembly. Set all discarded parts to

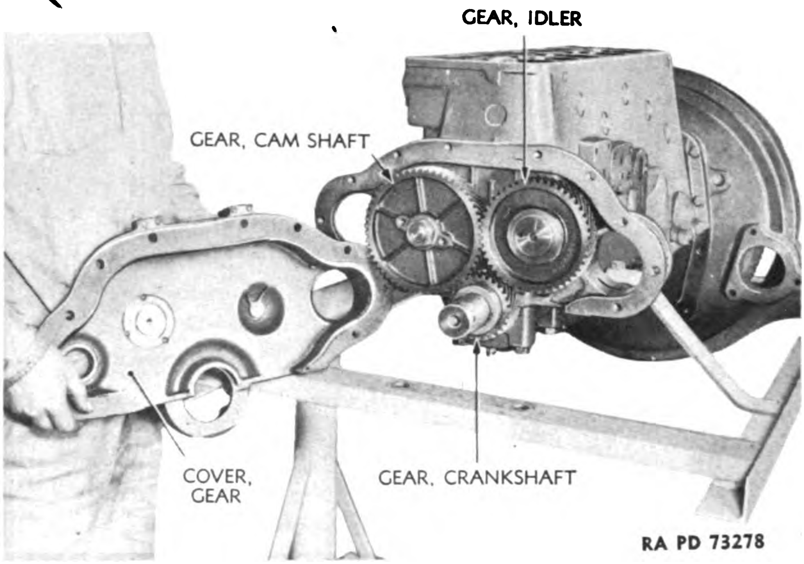


Figure 47 — Gear Cover Removed

one side, and mark in such a manner, that they will not become mixed with the new parts intended for replacement when the unit is assembled. When out-of-round, taper, or wear exceeds limit values specified, a new part or a permissible reworking of an old part to the standard of oversize or undersize is the only remedy, except complete replacement of the part or parts. If available, the magna-flux inspection process should be applied to all steel parts except ball and roller bearings, studs, standard nuts, and washers.

(1) BUSHINGS. Loose, damaged, or worn bushings must be removed, and new ones installed.

(2) STUDS. Any loose, broken, or damaged stud, or any stud that has been turned until it does not have proper height above its flange, must be removed, and a 0.003 inch oversize stud installed.

(3) CYLINDER BLOCK AND CRANKCASE.

(a) Check block for cracks.

(b) Check top surface for squareness, and replace, if necessary.

(c) Inspect all expansion plugs and remove loose or damaged plugs. Replace with new plugs.

(d) Examine case for cracks. If it is cracked, it must be repaired or replaced.

(e) Examine all studs for looseness and thread condition. Damaged studs and those impossible to tighten should be replaced.

ENGINE AND ACCESSORIES

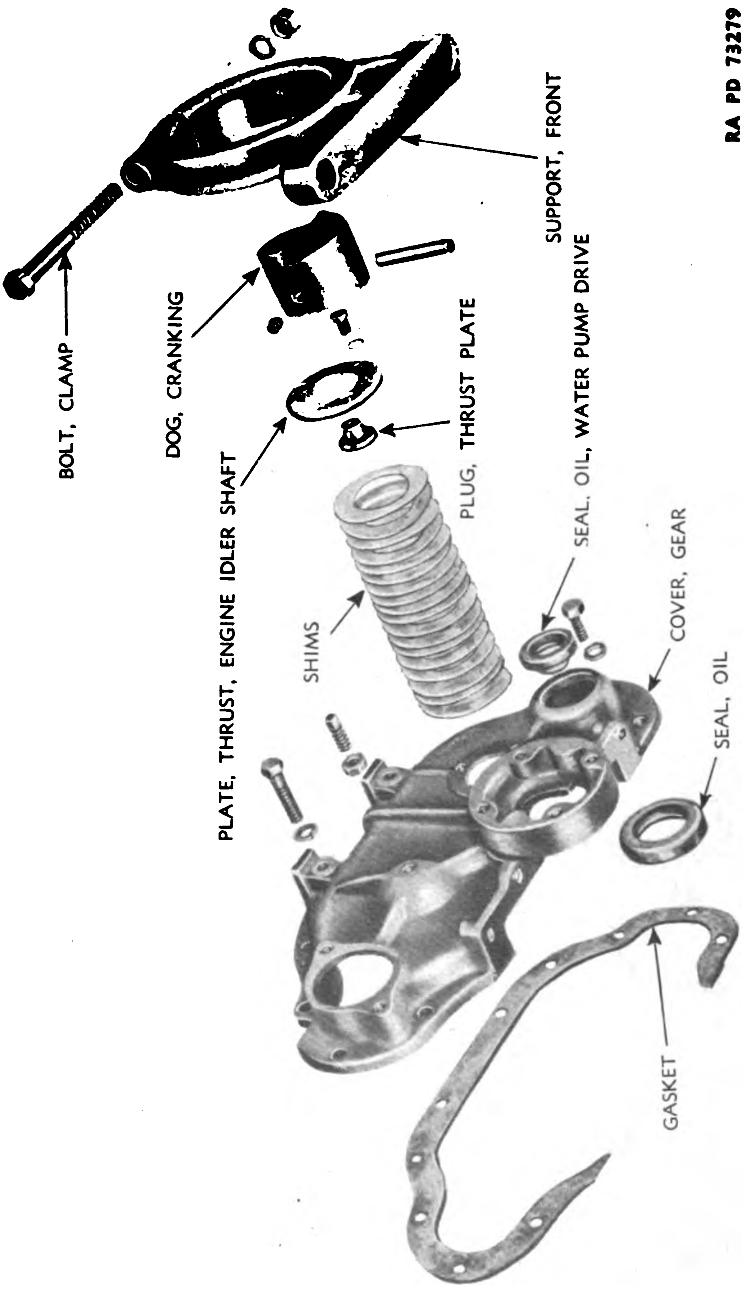
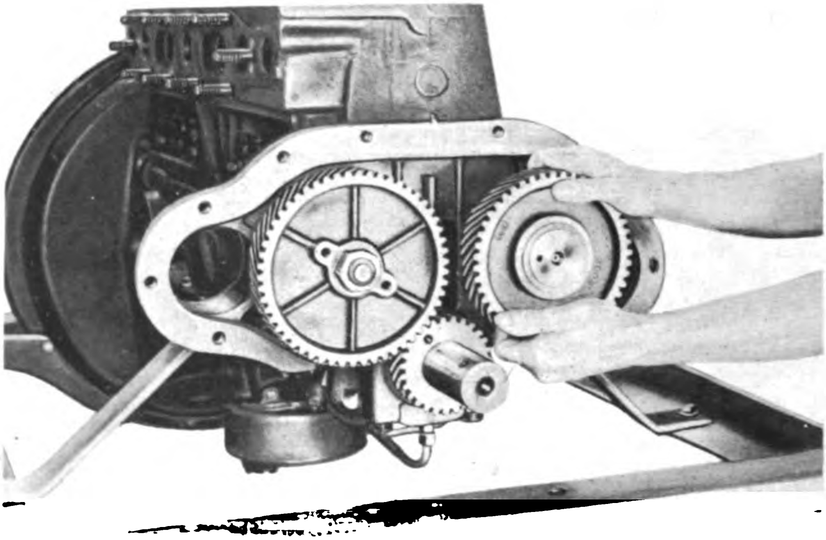
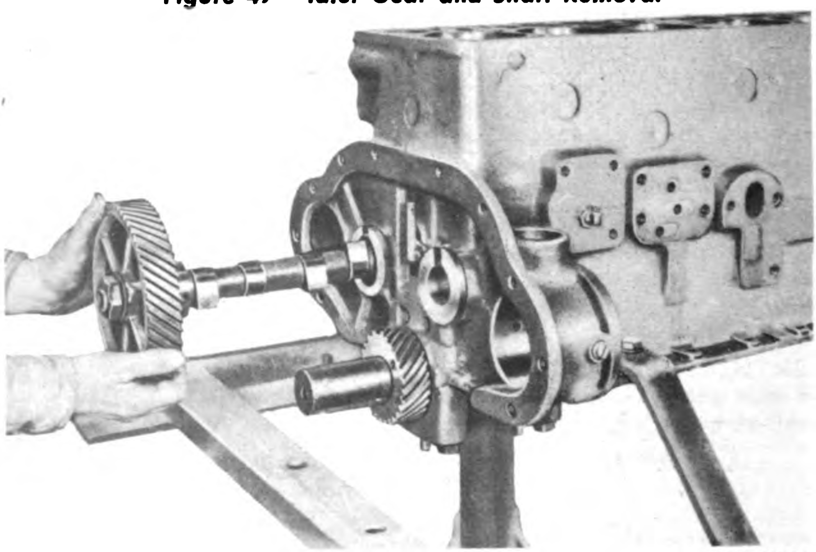


Figure 48 — Gear Cover, Front Engine Support, and Cranking Dog — Exploded View



RA PD 73280

Figure 49 — Idler Gear and Shaft Removal

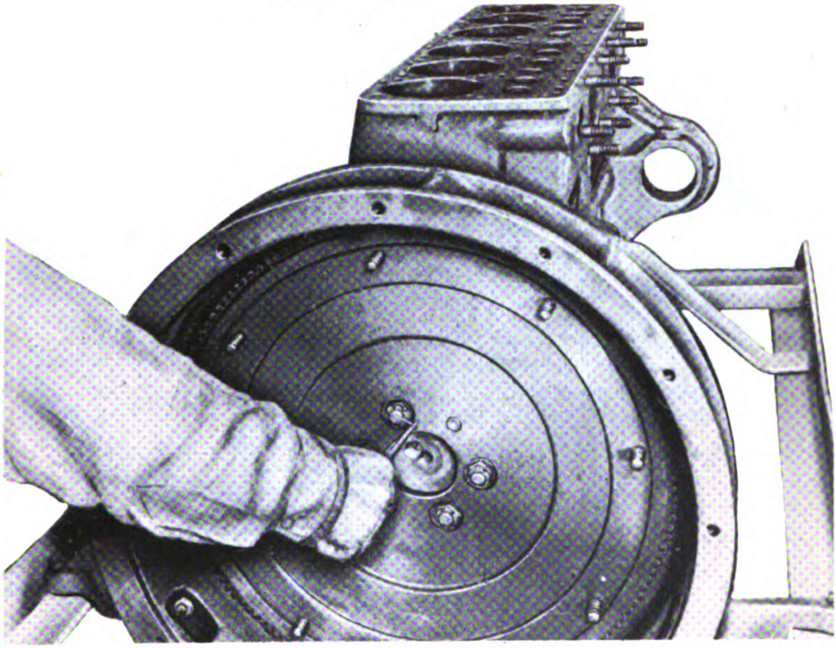


RA PD 73281

Figure 50 — Camshaft and Gear Removal

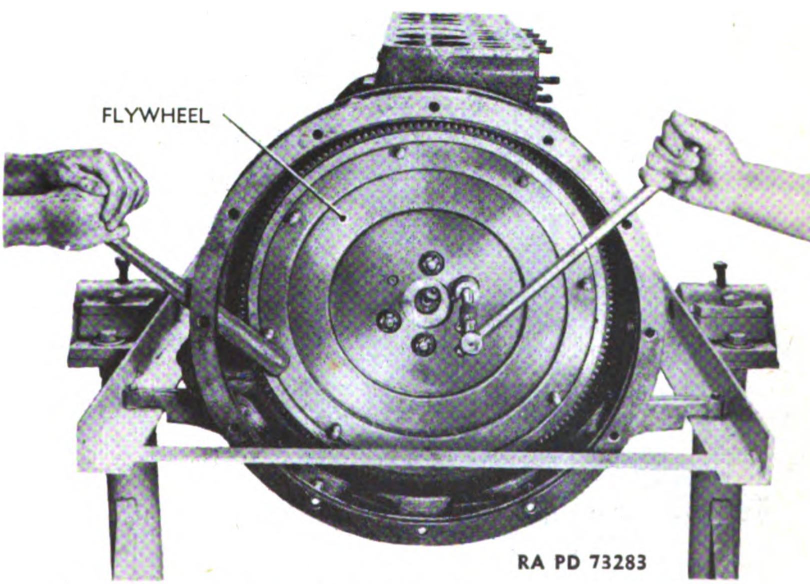
(f) Examine the four removable, babbitt-lined camshaft bearings, and replace, if necessary.

(g) Measure the cylinder bores with an inside micrometer to determine taper and out-of-round caused by wear. The measurements should be made at the top of the cylinder bore, preferably in the first



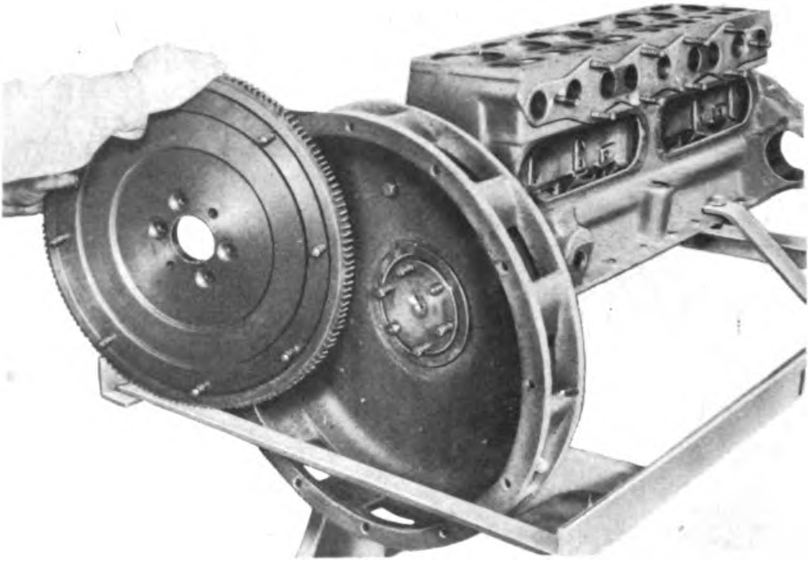
RA PD 73282

Figure 51 — Removing Cotter Pins Securing Flywheel Stud Nuts



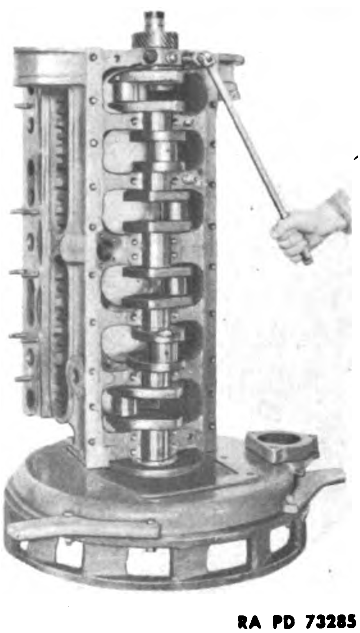
RA PD 73283

Figure 52 — Removing Nuts from Crankshaft Flywheel Studs



RA PD 73284

Figure 53 — Flywheel Removed



RA PD 73285

Figure 54 — Crankshaft Bearing Removal

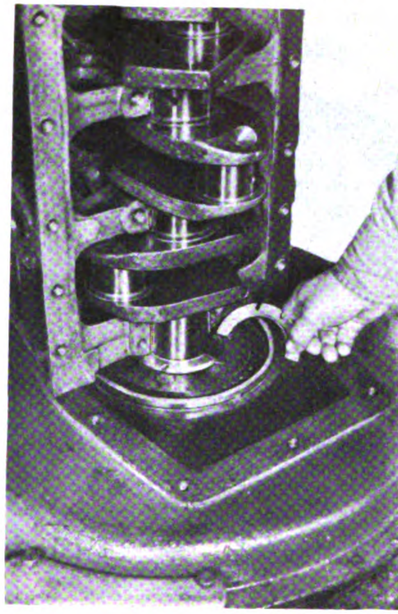


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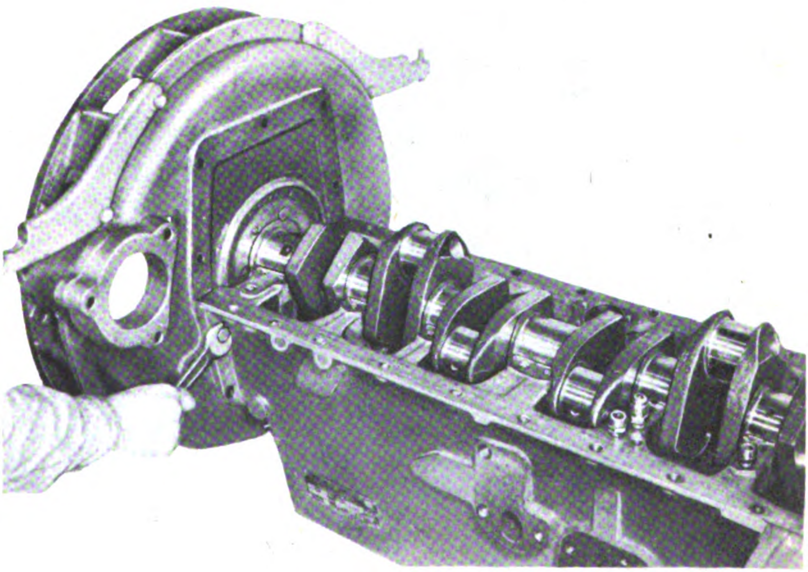
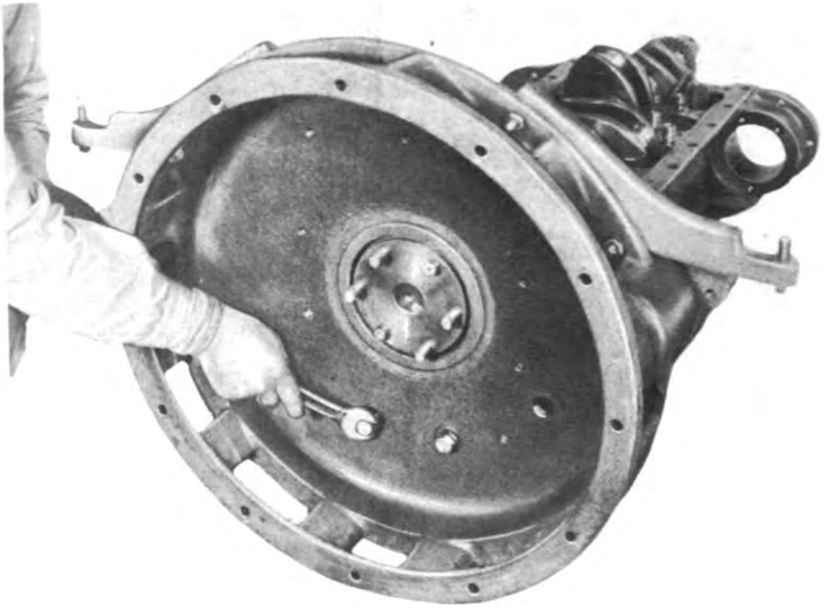
Figure 55 — Thrust Washer Removal



RA PD 73287

Figure 56 — Removing Bell Housing Cap Screws (1)



RA PD 73288

Figure 57 — Removing Bell Housing Cap Screws (2)

RA PD 73289

Figure 58 — Bell Housing Removed

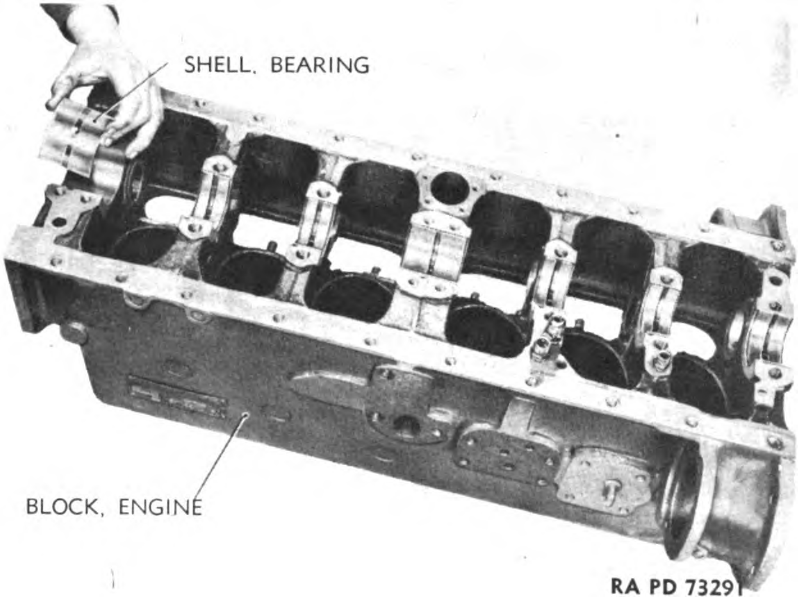
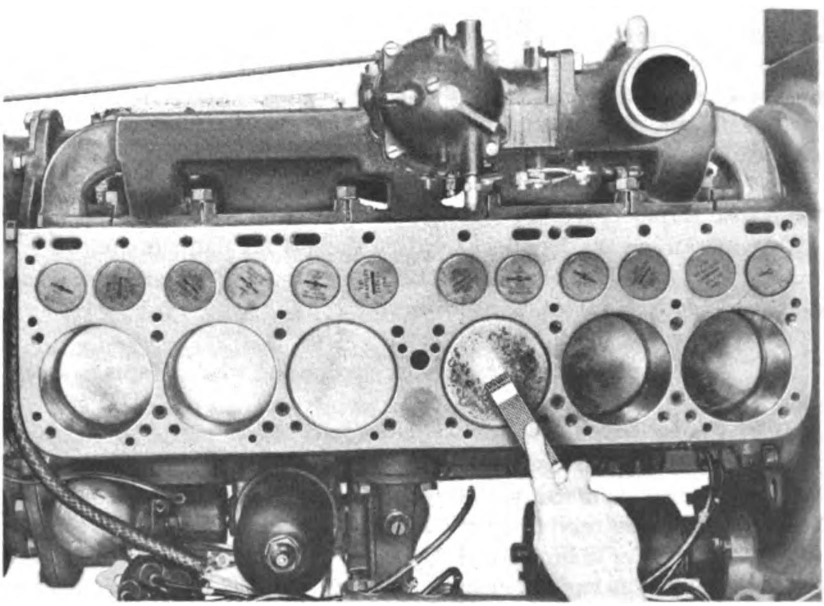
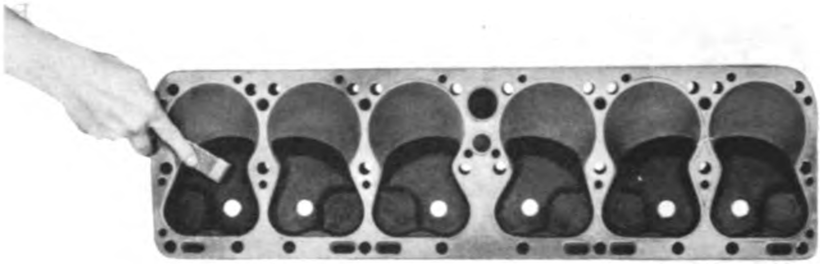


Figure 59 — Upper Bearing Shell Removal



RA PD 56910

Figure 60 — Scraping Carbon from Piston



RA PD 56909

Figure 61 – Scraping Carbon from Cylinder Head

½ inch of top piston ring travel, in several places around the inside circumference of the bore, and again in several places near the bottom of the cylinder bore. If the difference between the top and the bottom measurements exceeds 0.008 inch, the cylinder should be rebored by fifth echelon personnel.

(h) Inspect valve stem and push rod guides for wear. Replace all worn guides.

(4) CRANKSHAFT.

(a) The crankshaft main bearing and connecting rod journals should be measured for wear with a micrometer. If any of these journals show excessive wear, they should be reground and fitted with the next standard undersize shells by fifth echelon personnel.

(b) Check crankshaft for alinement by placing it on "V" blocks, and using a dial indicator on two center journals.

(c) Inspect the four rear flange studs for stripped threads and looseness. Replace, if necessary.

(d) Examine the flywheel locating dowels for damage and fit.

(e) Examine the crankshaft timing gear for excessive wear or damaged teeth. Replace, if necessary.

(5) PISTONS.

(a) Check pistons for cracks or excessive wear. Replace with new pistons.

(b) Check piston pins for wear. Replace worn pins.

(6) CONNECTING RODS.

(a) Inspect connecting rods, caps, and shells. All connecting rod bearing shells are replaced with new ones at every major overhaul.

(b) Check for damaged or twisted rods. A slightly twisted rod can be realined. A badly twisted or damaged rod should be replaced.

(c) Inspect cap screws, nuts, and piston pin locking screws for wear or damage. Replace if needed.

(7) VALVES.

(a) Inspect for warping or elongation of stem. Replace if any is evident.

(b) Inspect for burning, pitting, or excessive wear of face. Replace if any is evident.

(c) Inspect for wear of stem as determined by micrometer. Replace if necessary.

(d) Inspect for weak or broken valve spring. Replace if necessary.

(8) VALVE STEM GUIDES. Inspect all valve stem guides in the upper crankcase. If they do not check with the recommended fits (par. 139), replace with new ones.

(9) VALVE TAPPETS AND SCREWS. Inspect valve tappets and screws for wear. Replace if necessary.

(10) CAMSHAFT.

(a) Examine timing gear on front for excessive wear and damaged teeth. Replace damaged or badly worn gear.

(b) Inspect cam journals and oil pump driving gear in the center of the shaft. If this gear is badly damaged, the entire shaft must be replaced.

(11) FLYWHEEL.

(a) Inspect flywheel ring gear for broken or worn teeth. Replace with new gear, if necessary.

(b) Inspect flywheel for elongation of stud and dowel holes. If any elongation is evident, replace flywheel.

c. 750-hour Maintenance Procedure.

(1) After an engine has been run for 750 hours, it should be treated as follows:

(a) Remove cylinder head, and thoroughly clean out all deposits (figs. 60 and 61).

(b) Remove manifold, and clean out all deposits.

(c) Remove all valves, and clean out valve guides with SOLVENT, dry-cleaning.

(d) Clean and regrind intake valves, making sure all deposits and gums are cleaned off the valve stems and under surfaces of the valves.

(e) Reface exhaust valve seats in block. (If refaced valve seats are wider than 1/8 inch, they should be narrowed by a 60-degree stone or tool, taking material off the inside port until 1/8 inch width of seat is secured.)

(f) Replace exhaust valves with new valves. (If new material is not available, valves can generally be reused if refaced in grinder and valve stems thoroughly cleaned of corrosion and deposits. Stems should then be polished with CLOTH, crocus, or similar material.)

(g) Adjust tappets to 0.010 intake and 0.016 exhaust. This is the first setting for a cold engine. After the engine has been run sufficiently to warm up, the clearances should be rechecked, and set to 0.006, intake and 0.010, exhaust.

(h) Clean top of pistons and cylinder block of all deposits. Flood piston tops with oil, turning engine over by hand, and wiping oil off top of cylinder bores when piston is at bottom of stroke. This is to remove fine particles of deposits which may work down between piston and cylinder wall during cleaning operation.

(i) Reinstall cylinder head, using new cylinder head gasket.

(j) Install new spark plugs.

(k) Install manifold, using new gasket.

(l) Clean radiator core with compressed air and brush, and install new fan driving belt, if required.

(m) Install new distributor points and set gap for 0.020 inch. Lubricate the cam and pivot point of the new breaker arm, and check spring tension on the arm. Set ignition timing on top dead center.

(n) Dismantle and clean carburetor jets and check float mechanism and needle valves.

(o) Reassemble all accessories and connections, start engine, and warm up at idling speed.

(p) Recheck valve tappets for proper clearance as indicated in step (9) above.

(q) Install valve cover plates with new cork gaskets. (Use gasket cement on valve cover side only.) NOTE: It is assumed that such parts as oil filter and air cleaner will be thoroughly washed and serviced, and that the lubricating oil will have been drained and replenished. It is not necessary to open up the crankcase at this time unless there is evidence of loose bearings; or, due to dusty conditions or neglect of air cleaner servicing, the cylinder and pistons show abnormal wear.

d. Engine Repairs.

(1) CARBON REMOVAL. Whenever the cylinder head is taken off, the carbon deposits should be removed from the inside of the head, the top of the block pistons and valves. This can be done by scraping with a scraping tool (figs. 60 and 61).

(2) REMOVING BROKEN STUDS.

(a) Remove studs broken beyond the surface of the cylinder block with a stud remover.

(b) Remove studs broken flush with cylinder block or below the surface, by drilling a hole, about one-half the diameter of the stud, and the length of the stud, through its center. With a hammer, tap a stud removing tool into the drilled hole. Screw the stud from the cylinder block.

(3) REPAIRING DAMAGED THREADS.

(a) Burred threads are corrected by running a thread tap through them.

(b) Stripped threads can be corrected by cutting threads oversize, and replacing stud or screw with an oversize part, or by filling hole with weld, drilling out, and tapping.

(4) REPLACING WORN VALVE GUIDES.

(a) With a scale and straightedge, measure the exact distance the top of the worn valve guide is from the top machined surface of the cylinder block.

(b) Place a valve guide pilot in the top of the worn valve guide and, with a hammer, drive out guide.

(c) Place new valve guide in position. With pilot bar and hammer, drive new valve guide into cylinder block until the top of the new valve guide is the distance from the top of the cylinder block ascertained in step *(a)*, above.

(d) Ream the new valve guide with a straight fluted reamer to obtain the proper clearance for the valve stem (0.001 to 0.0015).

(5) INSTALLING CAMSHAFT BEARINGS. If inspection indicates that camshaft bearings require replacing, proceed as follows:

(a) Press out worn bearings with an arbor press.

(b) Press in new bearings, making sure that each bearing oilhole lines up with the oil passage in the cylinder block. Also make sure that the inner surface of the bearing retaining hole and the outer surface of the bearing are clean before the new bearing is installed.

(c) Line-ream the bearings to secure a clearance of 0.0015 to 0.0025 inch between each journal and its respective bearing surface.

(6) RESURFACING VALVE TAPPET SCREWS. If no new valve tappet screws are available, the old screws can be reused by resurfacing the top face with a file.

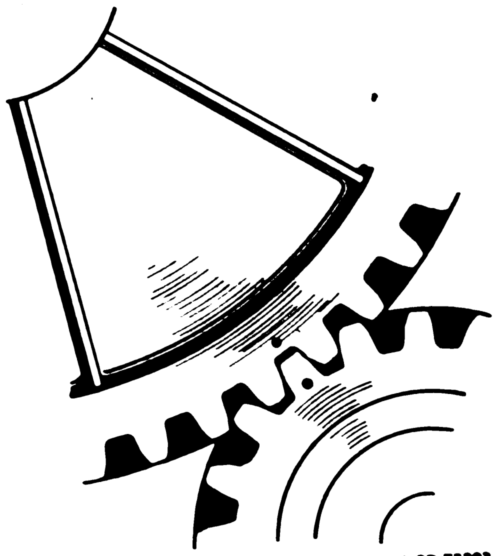
(7) REAMING VALVE SEATS. Inspect valve seats, and if they are pitted or if new guides have been installed, the seats should be refinished. Valve seat tools with $\frac{3}{8}$-inch diameter pilots are required. Valve seats are finished on a 45-degree angle, and should have an even width of $\frac{1}{8}$ inch to $\frac{5}{32}$ inch all the way around.

(8) REFACING VALVES. Inspect valves carefully, and if the stems are badly worn or are not straight, the valves should be replaced with new ones. However, valves that are only slightly pitted can be used by refacing them on a valve face grinder. Valves must have an accurately finished face of the correct angle. Care should be taken, while grinding, not to remove too much material from valve face.

(9) GRINDING VALVES. When grinding or lapping each valve to its seat, be sure the tappet is in such position that it does not hold the

RA PD 73292

Figure 62 — Installing Piston Rings



RA PD 73293

Figure 63 — Proper Meshing of Crankshaft and Camshaft Gears

valve off its seat. Use a light coil spring under each valve as it is being lapped in, to raise the valve off its seat during the process. Proceed as follows:

(a) Place each valve in its proper valve opening in the cylinder block.

(b) Place a small amount of COMPOUND, grinding, valve, fine, around the face.

(c) With only light pressure, rotate the valve only part of a turn with a screwdriver or other suitable tool before raising it off its seat and rotating while off to a new position before again lightly bringing it against the seat for another part of a turn. Avoid a continuous round and round motion that would cut grooves in the valve or seat. After the process of lapping has been repeated until a bright silver-like band of uniform width is produced on valve and seat, then clean off all traces of the compound, and test each valve for a tight seat, by making pencil marks across the face of the valve at short intervals, and then rotate the valve against its seat for part of a turn and with a firm pressure. Again lift out, and observe if the pencil marks are all rubbed out on the contact surface; if not, regrind until this test shows a gas tight mating of valve to seat. After valves have been reseated, adjust tappets as outlined in paragraph on valve tappet adjustment.

(10) Piston Ring Replacement (fig. 62).

(a) *Gap.* When installing new piston rings, each ring should be tried in the cylinder bore to see if it has the correct gap of 0.015 inch to 0.020 inch. If necessary to increase the gap by filing the ends, be sure to file so the ends are parallel.

(b) *Clearance.* Each new ring should be tried for clearance in the piston groove by rolling the ring all the way around the groove. If the grooves in the piston have been carefully cleaned, it will be found that the rings will fit correctly in this respect, but if they are not free, they can be lapped slightly on a sheet of CLOTH, abrasive, aluminum-oxide, 2/0, laid on a flat surface. Use a light uniform pressure when lapping.

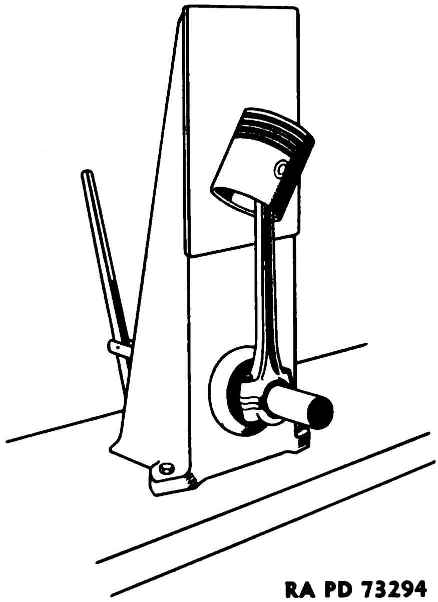
(11) Flywheel Ring Gear Replacement. If inspection indicates that a new ring gear is required, it should be replaced as follows:

(a) Saw through and knock off old ring gear.

(b) Heat new ring gear so that it will fit into position on flywheel. Place on flywheel, and allow it to cool.

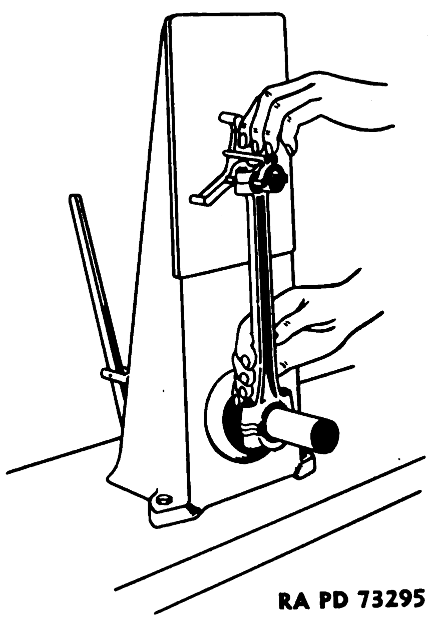
(12) Valve Timing.

(a) The proper timing of the valves depends on the proper meshing of the camshaft gear with the crankshaft gear, and the proper valve tappet clearance. These gears are marked for this purpose with a prick punch mark near the end of a tooth on one, and at the base of a



RA PD 73294

Figure 64 — Checking Connecting Rod for Bend



RA PD 73295

Figure 65 — Checking Connecting Rod for Twist

tooth space on the other. The mark in each instance is on the front face of the gear. When these marks line up (fig. 63), the valve timing is correct. The punch mark for timing on a new gear has the same position relative to the keyway as on the old gear. Therefore, one or more new gears can be installed, and the valves put in correct timing by simply meshing the gears so the marks line up.

(b) The valve timing with respect to crankshaft or flywheel travel in degrees and minutes is as follows: Intake opens 1°– 52½ inch past top center; intake closes 46°– 52½ inch past bottom center. Exhaust opens 43°– 7½ inch before bottom center; exhaust closes 1°– 52½ inch past top center. In checking valve opening or closing in degrees of crank travel, the valve clearance is set to 0.010 inch clearance for intake, and 0.016-inch clearance for exhaust valve on cylinder being used as a check. For proper running clearance, see subparagraph c (1) *(g)*, above.

(13) CONNECTING ROD AND PISTON.

(a) *Bent Connecting Rod.* Clamp assembled connecting rod and piston, without piston rings, onto a connecting rod alining fixture (fig. 64). Draw piston up to the surface plate. If the piston lies flat against the plate, the connecting rod is straight. If the piston will not lie flat, the rod is bent and must be replaced or straightened.

(b) *Twisted Connecting Rod.* Clamp connecting rod without piston onto rod alining fixture. Check for twist as shown in figure 65. If all of the legs of the tripod do not set squarely on the face plate, the rod is twisted, and must be replaced or realined.

(14) FITTING PISTON RINGS.

(a) Measure cylinder wall wear with a dial indicator, to determine whether to use standard or oversize piston rings. Slip a piston ring into the cylinder. Push it down about an inch from the top of cylinder block with a piston. Using a feeler gage, measure end gap. If end gap exceeds 0.020 inch, use an oversize ring. If end gap is less than 0.015 inch, file ends of ring on a fine mill file secured in a file holding fixture or in a vice. Repeat these steps with all the rings. Test each ring in the cylinder in which it is to be used.

(b) *Piston Ring Grooves.* Carefully examine the ring grooves in each piston. Remove any carbon with a broken piston ring or standard piston ring groove cleaner. Carefully remove any burs with a fine file. Clean carbon from oil return holes in oil ring groove.

(c) *Cylinder Bores.* If cylinder wall wear exceeds 0.005 inch, walls will have to be rebored or honed, and oversize pistons fitted. If cylinder wall wear is 0.003 inch to 0.005 inch, install oversize piston rings. If cylinder wall wear is less than 0.003 inch, install standard piston rings. Inspect top of cylinder walls. If walls are worn, the top $\frac{3}{16}$ inch will be unworn, and will appear as a ridge. Remove ridge with a ridge reamer.

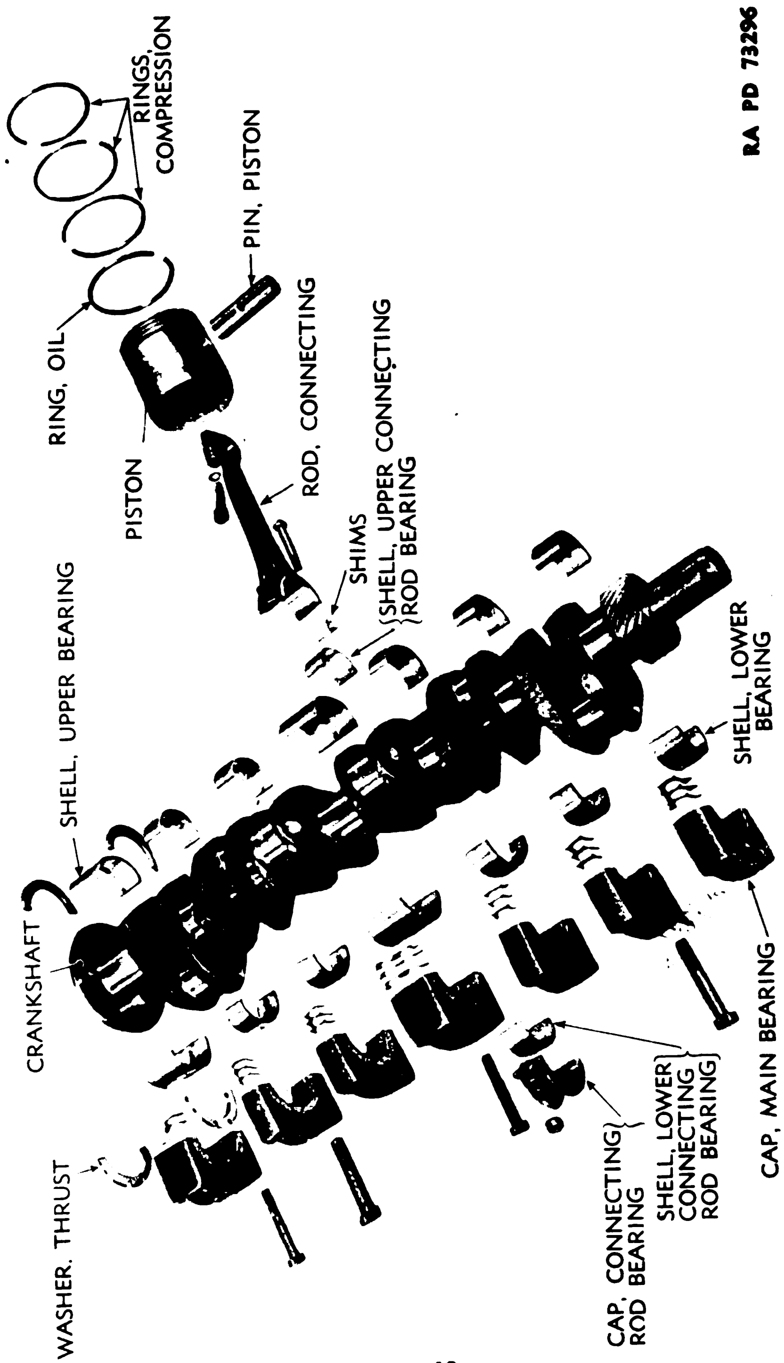


Figure 66 — Crankshaft, Piston and Bearings — Exploded View

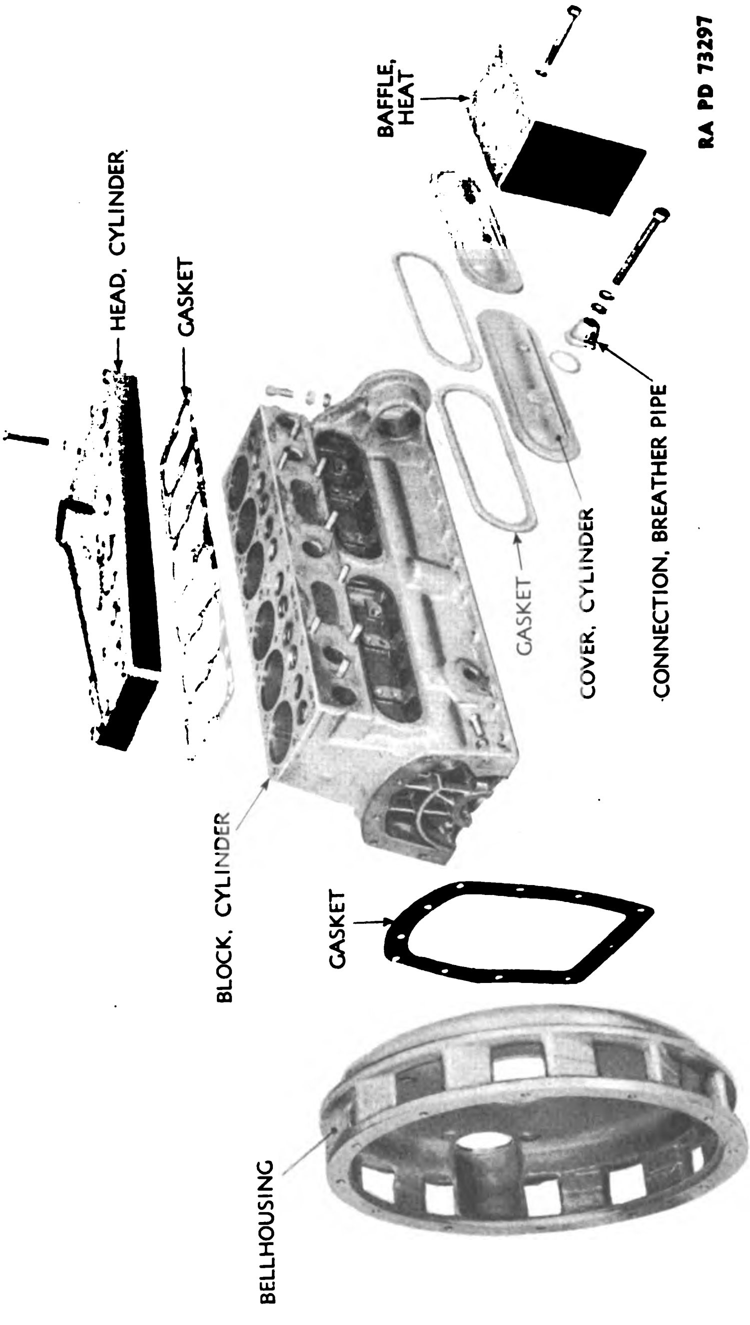
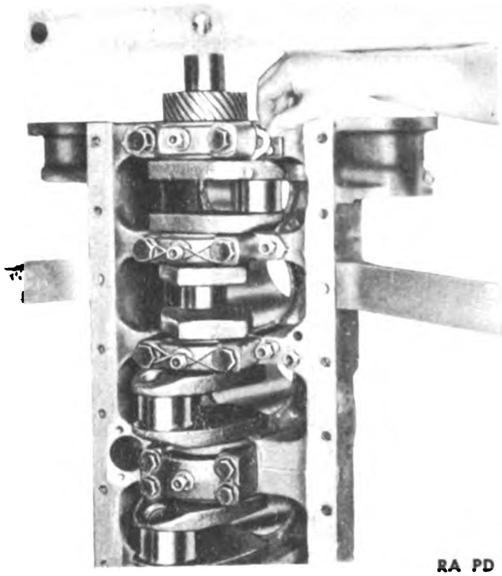
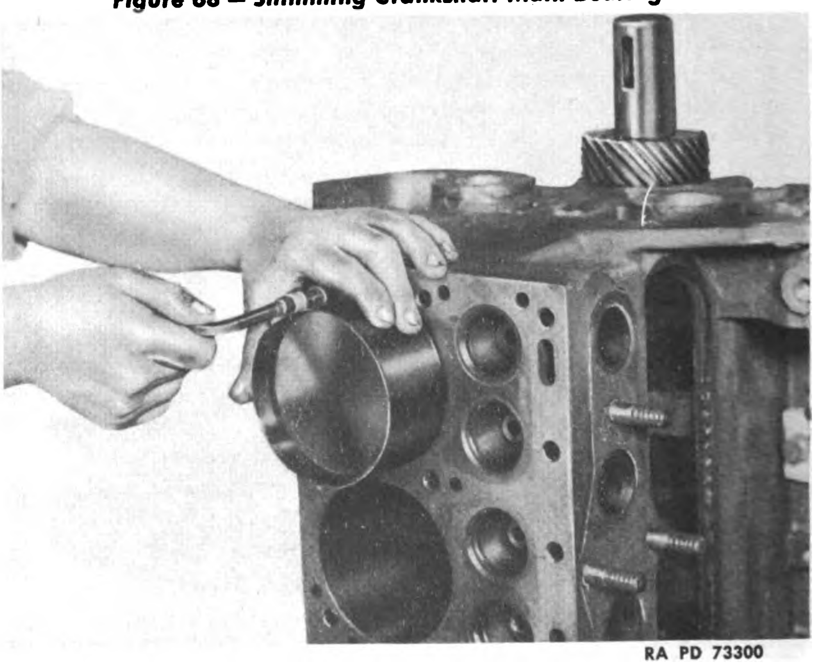


Figure 67 — Cylinder Block, Head, and Bell Housing Assembly



RA PD 73298

Figure 68 — Shimming Crankshaft Main Bearing



RA PD 73300

Figure 69 — Tightening Piston Ring Compressor

24. ASSEMBLY (figs. 66 and 67).

a. Procedure.

(1) Set upper bearing shells in place in upper bearings, carefully installing each shell in the bearing from which it was removed (fig. 59).

(2) Set crankshaft in position in upper bearings after coating bearing surface with OIL, engine (crankcase grade). Fit thrust washer halves into place between rear main bearing and crankshaft flange.

(3) Install bell housing (figs. 58 and 57).

(4) Install crankshaft main bearings (fig. 54).

(a) Place crankshaft rear main bearing cap and shell in position, shim up on side opposite the locking lug with the shims which were previously used. Secure bearings with cap screws, and rotate crankshaft to test for binding. If replacing the original cap and shells, crankshaft should turn freely without binding. If new bearing cap or shells have been installed, place shims until the crankshaft can be turned, but only with considerable effort. Then add shims to the one side to gain the required clearance of 0.002 to 0.003 inch (fig. 68). Tighten cap screws (tension wrench) to 70 foot-pounds tension. Wire each pair of cap screws together with No. 12 wire, running wire through holes in cap screw heads.

(b) Install center main bearing cap and shell. Repeat procedure outlined in step *(a)*, above, given for installation of rear main bearing.

(c) Install front and intermediate bearing caps. Repeat procedure outlined in step *(a)*, above except that proper tension wrench tension is 105 foot-pounds.

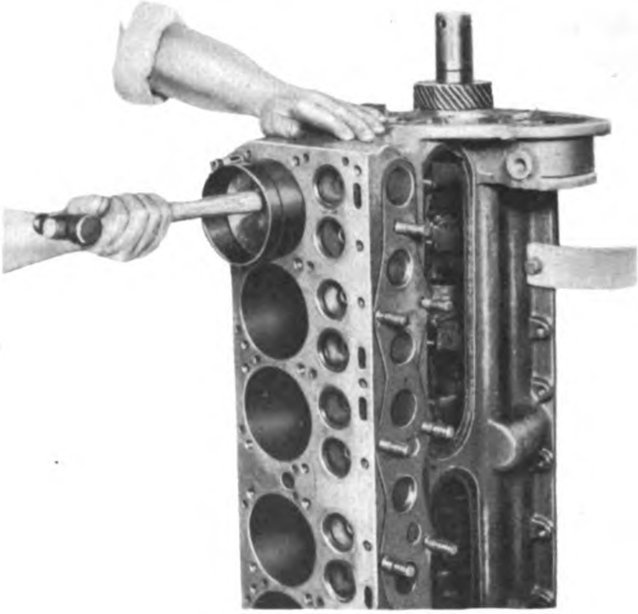
(5) Place flywheel against end of crankshaft, inside bell housing. Line up screw and dowel holes in flywheel and crankshaft. Install the four castellated nuts finger tight. Hold wood block against a flywheel stud to keep flywheel from moving while tightening castellated nuts (fig. 52).

(6) Holding camshaft clear, carefully pass camshaft into camshaft bearings in engine block. One man should carefully guide the shaft through the bearing so that cams do not injure the babbitt bearing linings (fig. 50).

(7) Mesh camshaft gear (par. 23 d (12) *(a)*).

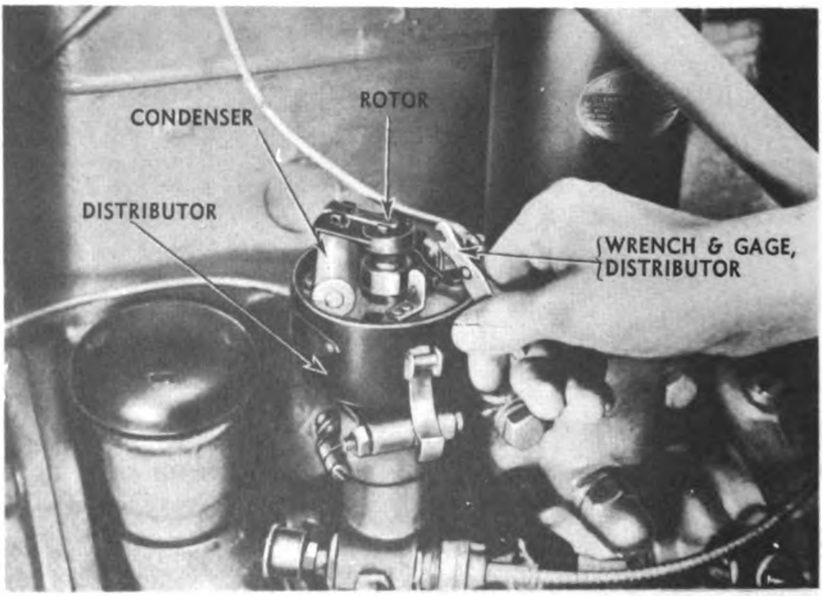
(8) The third gear from the left is the idler gear, which acts only in transmitting power to the accessory or water pump drive. Press idler gear stub shaft into place, and mesh with the camshaft gear at any point (fig. 49).

(9) Press oil retainer ring, with outside rubber gasket in place, onto crankshaft. Set timing gear cover in place, and attach to block with cap screws (fig. 46).



RA PD 73301

Figure 70 — Installing Piston Using Piston Ring Compressor



RA PD 73509

Figure 71 — Gaging Distributor Breaker Points

(10) Slide cranking dog over crankshaft, and adjust on shaft until drift holes in dog aline with hole in shaft. Drive in drift pin. Tighten set screw holding drift pin in place.

(11) Slide outboard support ring over cranking dog, with horizontal cap screw at top. Tighten screw to hold firmly in place (fig. 44).

(12) Assemble pistons and connecting rods.

(a) Line up oilholes in piston and piston pin bushing, and press bushing into piston. Repeat operation to install other bushing. Ream out bushings to obtain a 0.0002 to 0.0003 piston pin clearance.

(b) Hold connecting rod in position in piston. Push piston pin in piston and connecting rod, and tighten connecting rod piston pin lock screw.

(c) Slide one oil and three compression piston rings on piston with piston ring expander.

(d) Repeat the above steps on all five remaining pistons.

(13) Install pistons and connecting rods.

(a) Coat piston and bearing surface of connecting rod with a thin coat of OIL, engine (crankcase grade). Compress piston rings on No. 1 piston ring compressor (fig. 69).

(b) Insert connecting rod and piston assembly connecting rod first, into top of No. 1 cylinder. Be sure side of piston marked "FRONT" is toward the front of engine. Tap top of piston into cylinder with wood block or hammer handle (fig. 70). Remove piston ring compressor from piston as piston rings enter cylinder.

(c) With upper connecting rod bearing shell in place, fit connecting rod over crankshaft. Insert connecting rod cap screws through holes in base of rod. Place connecting rod cap, with bearing shell in place, on screws. Insert the same shims originally removed around cap screw on side opposite the camshaft. Connecting rod bearing clearance should be 0.0015 to 0.002. Install connecting rod castellated nuts, tightening them to 63 foot-pounds pressure. Gage clearance and add or remove shims if proper clearance is not already gained. Insert cotter pins through holes provided in cap screw shank.

(d) Repeat procedure outlined in steps *(a)* through *(c)* above, for all pistons.

(14) Insert oil pump in position, and attach bracket with cap screws (fig. 40).

(15) Set bearing lubricating oil line in position, and connect end fittings to oil pump and oil line fittings on main bearing caps (fig. 41).

(16) Bring oil pan up to crankcase with gaskets in position, and attach with cap screws (fig. 39).

(17) Spin each tappet screw nut onto the tappet screw. Screw tappet screw into tappet (fig. 34).

(18) Return assembled tappets to their original position in the clusters. Install complete clusters in valve chambers with cap screws (fig. 37).

(19) Lower valves through engine block and valve guide, stem first, being careful to return each valve to its former position. Bring each valve spring and valve spring seat together, the seat inserted at the end that is most loosely coiled. Slide each valve up in sequence, and insert spring and seat in position between top of valve chamber and tappet. Insert the valve spring lifter between top of tappet cluster and spring seat. Compress spring, and lock lifter in place. Install key in slot of valve stem (fig. 35), release lifter tension on spring, and remove lifter.

(20) ADJUST TAPPETS. From front to rear of engine, exhaust valves are Nos. 1, 4, 5, 8, 9, and 12. Valves 2, 3, 6, 7, 10, and 11 are intake. Cylinders are also numbered from front to rear. To adjust valves for No. 1 cylinder, turn engine over with hand crank until intake valve of No. 6 cylinder begins to open. Hold valve adjustment bolt head with one wrench, and loosen lock nut with the other. Adjust so that clearance between bolt head and valve stem will just take 0.010-inch gage in case of intake valves, and 0.016-inch gage for exhaust valves. Crank engine until No. 2 cylinder intake valve opens; adjust valves in No. 5 cylinder. As No. 4 cylinder intake valve opens, adjust valves in No. 3 cylinder. When No. 1 cylinder intake valve opens, adjust valves in No. 6 cylinder. When No. 5 cylinder intake valve opens, adjust valves in No. 2 cylinder. When No. 3 cylinder intake valve opens, adjust valves in No. 4 cylinder. This is the first setting for cold engine. After engine has been run sufficiently to warm up, clearances should be rechecked and set to 0.006 intake and 0.010 exhaust.

(21) Set cylinder head on engine block with a new gasket in place. Secure head to block with cap screws, while locating and attaching by the same means, the ignition wire tube flange, choke and ignition line bracket flange, fuel line bracket flange, and ignition coil bracket flange. The cylinder head cap screws should be tightened in rotation, a few turns at a time, beginning at the center of the head and working to the outside. They should be tightened with a tension wrench to a tension of 60 foot-pounds when using copper asbestos cylinder head gaskets, or 75 foot-pounds when using steel asbestos cylinder head gaskets. The final tightening should be done after the engine has been run, and is thoroughly warmed up. Tension readings should be checked after the first 10 hours of operation.

(22) Screw spark plugs with gaskets in place into cylinder head finger tight. With spark plug wrench, give each plug three-quarters of a turn.

25. INSTALLATION OF ACCESSORIES.

a. Procedure. This procedure is the reverse of that outlined in paragraph 21 a.

26. INSTALLATION.

a. Procedure. This procedure is the reverse of that outlined in paragraph 20 a. (See paragraph 15 for housing installation.)

27. TUNE-UP.

a. Procedure.

(1) One of the most important operations in the maintenance of the engine is proper engine tune-up. This operation, more than any other, determines whether or not the engine delivers the maximum in performance and economy. Only by accurately making the following checks and adjustments can the maximum performance of the engine be obtained.

(2) COMPRESSION.

(a) Before making any checks on an engine, it should be run for several minutes to warm it up and lubricate the valve mechanism. The compression of the engine should be checked first when tuning, because an engine with uneven compression cannot be tuned successfully.

(b) Remove all spark plugs. The ignition should be turned off, with the throttle valve in the open position.

(c) Insert the compression gage in a spark plug hole, and hold it tightly. Crank the engine with the starting motor until the gage reaches its highest reading, which requires only a few turns. Repeat the same test on all cylinders, and make a note of the compression on each.

(d) The compression on all cylinders should be 110 pounds or better, and all cylinders should read alike, within 5 to 10 pounds, for satisfactory engine performance.

(e) Should there be a low compression reading on two adjacent cylinders, it indicates a possible intercylinder leak, usually caused by a leak at a cylinder head gasket.

(f) If the compression readings are low or vary widely, the cause of the trouble may be determined by injecting a liberal supply of oil on top of the pistons of the low reading cylinders.

(g) Crank the engine over several times, and then take a second compression test. If there is practically no difference in the readings when compared with the first test, it indicates sticky or poorly seating valves. However, if the compression reading on the low reading cylinders is about uniform with the other cylinders, it indicates compression loss past the pistons and rings.

(h) The cause of low or uneven compression must be corrected before proceeding with an engine tune-up job.

(3) SPARK PLUGS (par. 80).

(a) Clean the spark plugs thoroughly in a spark plug sand blast cleaner. If the porcelains are badly glazed or blistered, the spark plugs should be replaced. All spark plugs must be of the same make and heat range.

(b) Adjust the spark plug gaps at 0.025 inch, using a feeler gage. *Do not bend the center electrode.*

(c) Care must be used when installing the spark plugs, or the setting of the gap may be upset. When installing the plugs, put a new gasket on the plug, screw the plug in finger tight, then tighten with the spark plug wrench one-half to three-quarters of a turn.

(4) BATTERY TEST.

(a) Connect the negative terminal of a voltmeter to the starting switch terminal, and the positive terminal of the voltmeter to a good ground.

(b) Crank the engine for 15 seconds. If the starting motor cranks the engine over at a good rate of speed with the voltmeter reading 5 volts or better, it indicates a satisfactory starting circuit, which includes the condition of the battery, terminals, and cables. However, if the cranking speed is slow, or the voltmeter reading is under 5 volts, the starting motor, battery, and battery cable terminals should be checked individually to locate the source of the trouble.

(5) DISTRIBUTOR (fig. 71).

(a) Remove the spark plug wires from the distributor cap and examine the terminals for corrosion. The wires should also be checked for damaged insulation and for being oil-soaked.

(b) Remove the distributor cap, and check the cap and distributor rotor for cracks or burned contacts.

(c) Check the automatic advance mechanism by turning the distributor cam in a clockwise direction as far as possible, then release the cam and see if the springs return it to its retarded position. If the cam does not return readily, the distributor needs to be disassembled, and the cause of the trouble ascertained.

(d) Examine the distributor breaker points. Dirty points should be cleaned, and pitted or worn points should be replaced. Check the points for alinement, and aline them if necessary.

(e) Hand crank the engine until the cam follower rests on a peak of the cam. Adjust the point gap to 0.020 inch (fig. 71), using feeler gage. This operation must be performed very accurately. Hand crank the engine until the cam follower is located between the cam peaks. Hook the end of a point scale over the movable point, and pull steadily

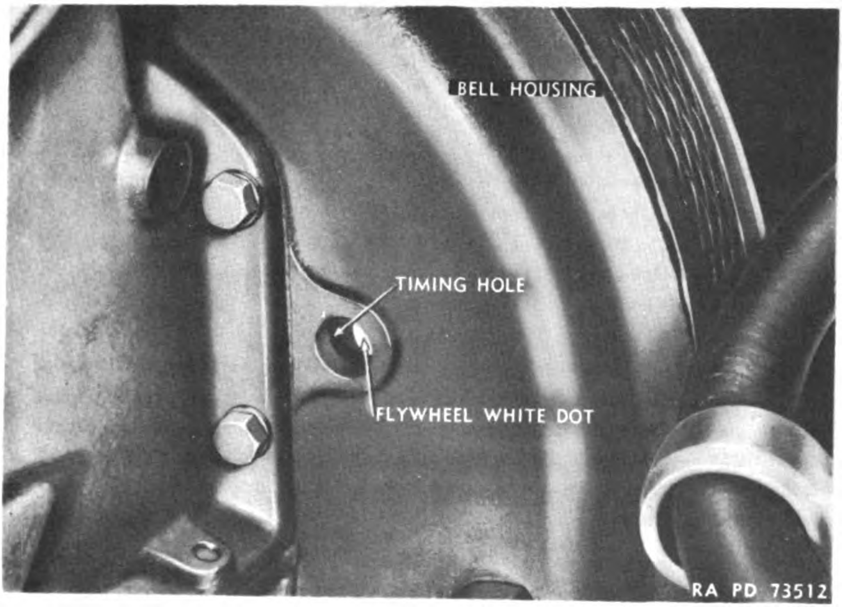


Figure 72 — Timing Hole in Bell Housing

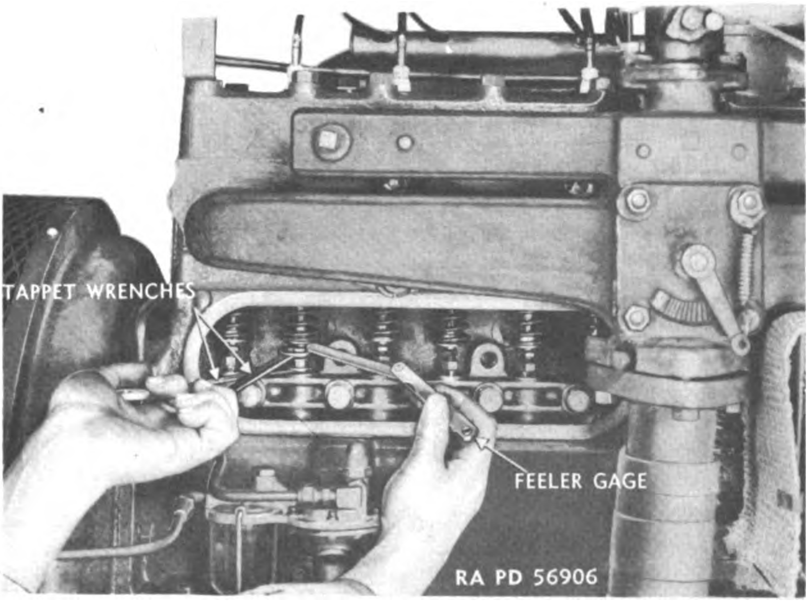


Figure 73 — Valve Tappet Adjustment

on the spring scale until the points just start to open. Scale should read between 17 and 20 ounces. Adjust the point pressure by loosening the screw holding the end of the contact arm spring. and slide the end of spring in or out as necessary.

(f) Reassemble distributor cap and spark plug wires. Make sure that the terminals of the primary wire from the ignition coil to the distributor are clean and tight.

(6) FUEL PUMP. Remove the sediment cup and screen and wash them thoroughly in SOLVENT, dry-cleaning. When reassembling, make sure that the cork gasket is in good condition and properly seated. Tighten all fuel pump connections.

(7) AIR FILTER (fig. 105).

(a) Remove the air filter from the carburetor. Remove the wing nut from the top, and take off the cover.

(b) Empty the oil out of the filter and clean out all oil and accumulated dirt. Wash body with SOLVENT, dry-cleaning, and wipe dry. Wash filter element by slushing up and down in SOLVENT, dry-cleaning. Dry thoroughly, either with an air hose or by letting it stand until dry. Fill the body of the filter to bead level with used crankcase oil or OIL, engine, (crankcase grade).

(c) Install the filter on the carburetor elbow. Tighten clamp.

(8) CARBURETOR.

(a) Adjust mixing screw at top until engine runs smoothly at idling speed. This screw controls the amount of air mixed with the fuel.

(9) IGNITION TIMING.

(a) Attach one wire of the neon-timing light to No. 1 spark plug, and the other wire to the No. 1 spark plug wire. Start the engine and run it at idling speed. Loosen distributor clamp and slowly rotate distributor body clockwise or counterclockwise until the white dot on the flywheel (fig. 72) is visible through the timing hole in the bell housing each time the light goes on.

(10) VALVE TAPPET ADJUSTMENT (fig. 73).

(a) Start the engine and while it is warming up, tighten cylinder head cap screws and manifold nuts. Where torque wrenches are available, the cylinder head cap screws should be tightened to 60 foot-pounds, if copper asbestos cylinder head gasket is used, and 75 foot-pounds if steel asbestos cylinder head gasket is used.

(b) Adjust the valve tappets according to the procedure given in paragraph 24 a (20).

(11) COOLING SYSTEM.

(a) Tighten all hose connections and examine for any indications of water leaks. Check the fan and exciter belts for cracks, oil-soaking and for proper tension.

Section II

COOLING SYSTEM

28. DESCRIPTION (fig. 74).

a. **General.** The cooling system consists of a radiator, radiator cooling fan, water pump, water passages in the cylinder block and head, thermostat, and the various connections between these units. It has a capacity of 36 quarts. The function of the cooling system is to maintain the engine at an efficient operating temperature. To perform this function properly, the system must be kept free of foreign matter that might tend to clog the water passages. The water pump must be leakproof, and must keep the water circulating in the system. The water passages in the cylinder block and head must be kept free from rust and corrosion so that heat may be properly dissipated. The hose sections must be in good condition, and all connections must be kept tight so that they will not leak. Cylinder head bolts must be kept tight to eliminate the possibility of exhaust gases entering the cooling system. Water is drawn from the bottom of the radiator by the water pump, and is forced under pressure through the water passages in the cylinder block and head and back into the top of the radiator. The thermostat, mounted in the cylinder head, assists in maintaining proper water temperature under operating conditions.

29. TROUBLE SHOOTING.

a. **Overheating.**

Possible Cause	Possible Remedy
Lack of water or antifreeze.	Fill cooling system.
Leaks at connections, hoses, radiator core, or cylinder head gasket.	Tighten all connections, repair radiator core, and tighten or replace all hoses.
Radiator dirty, inside or out.	Clean radiator thoroughly.
Dirty water.	Drain, and refill with clean water.
Clogged system.	Flush system (par. 30 d).
Loose fan belt.	Adjust or replace.
Broken fan belt.	Replace.
Water pump not operating.	Rebuild (par. 31).
Ignition timing incorrect.	Time engine (par. 27 a (9)).

on the spring scale until the points just start to open. Scale should read between 17 and 20 ounces. Adjust the point pressure by loosening the screw holding the end of the contact arm spring. and slide the end of spring in or out as necessary.

(f) Reassemble distributor cap and spark plug wires. Make sure that the terminals of the primary wire from the ignition coil to the distributor are clean and tight.

(6) FUEL PUMP. Remove the sediment cup and screen and wash them thoroughly in SOLVENT, dry-cleaning. When reassembling, make sure that the cork gasket is in good condition and properly seated. Tighten all fuel pump connections.

(7) AIR FILTER (fig. 105).

(a) Remove the air filter from the carburetor. Remove the wing nut from the top, and take off the cover.

(b) Empty the oil out of the filter and clean out all oil and accumulated dirt. Wash body with SOLVENT, dry-cleaning, and wipe dry. Wash filter element by slushing up and down in SOLVENT, dry-cleaning. Dry thoroughly, either with an air hose or by letting it stand until dry. Fill the body of the filter to bead level with used crankcase oil or OIL, engine, (crankcase grade).

(c) Install the filter on the carburetor elbow. Tighten clamp.

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(a) Adjust mixing screw at top until engine runs smoothly at idling speed. This screw controls the amount of air mixed with the fuel.

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(a) Start the engine and while it is warming up, tighten cylinder head cap screws and manifold nuts. Where torque wrenches are available, the cylinder head cap screws should be tightened to 60 foot-pounds, if copper asbestos cylinder head gasket is used, and 75 foot-pounds if steel asbestos cylinder head gasket is used.

(b) Adjust the valve tappets according to the procedure given in paragraph 24 a (20).

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(a) Tighten all hose connections and examine for any indications of water leaks. Check the fan and exciter belts for cracks, oil-soaking and for proper tension.

ENGINE AND ACCESSORIES

Section II

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Radiator dirty, inside or out.	Clean radiator thoroughly.
Dirty water.	Drain, and refill with clean water.
Clogged system.	Flush system (par. 30 d).
Loose fan belt.	Adjust or replace.
Broken fan belt.	Replace.
Water pump not operating.	Rebuild (par. 31).
Ignition timing incorrect.	Time engine (par. 27 a (9)).

on the spring scale until the points just start to open. Scale should read between 17 and 20 ounces. Adjust the point pressure by loosening the screw holding the end of the contact arm spring. and slide the end of spring in or out as necessary.

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(a) Start the engine and while it is warming up, tighten cylinder head cap screws and manifold nuts. Where torque wrenches are available, the cylinder head cap screws should be tightened to 60 foot-pounds, if copper asbestos cylinder head gasket is used, and 75 foot-pounds if steel asbestos cylinder head gasket is used.

(b) Adjust the valve tappets according to the procedure given in paragraph 24 a (20).

(11) COOLING SYSTEM.

(a) Tighten all hose connections and examine for any indications of water leaks. Check the fan and exciter belts for cracks, oil-soaking and for proper tension.

ENGINE AND ACCESSORIES

Section II

COOLING SYSTEM

28. DESCRIPTION (fig. 74).

a. General. The cooling system consists of a radiator, radiator cooling fan, water pump, water passages in the cylinder block and head, thermostat, and the various connections between these units. It has a capacity of 36 quarts. The function of the cooling system is to maintain the engine at an efficient operating temperature. To perform this function properly, the system must be kept free of foreign matter that might tend to clog the water passages. The water pump must be leakproof, and must keep the water circulating in the system. The water passages in the cylinder block and head must be kept free from rust and corrosion so that heat may be properly dissipated. The hose sections must be in good condition, and all connections must be kept tight so that they will not leak. Cylinder head bolts must be kept tight to eliminate the possibility of exhaust gases entering the cooling system. Water is drawn from the bottom of the radiator by the water pump, and is forced under pressure through the water passages in the cylinder block and head and back into the top of the radiator. The thermostat, mounted in the cylinder head, assists in maintaining proper water temperature under operating conditions.

29. TROUBLE SHOOTING.

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Possible Cause	Possible Remedy
Lack of water or antifreeze.	Fill cooling system.
Leaks at connections, hoses, radiator core, or cylinder head gasket.	Tighten all connections, repair radiator core, and tighten or replace all hoses.
Radiator dirty, inside or out.	Clean radiator thoroughly.
Dirty water.	Drain, and refill with clean water.
Clogged system.	Flush system (par. 30 d).
Loose fan belt.	Adjust or replace.
Broken fan belt.	Replace.
Water pump not operating.	Rebuild (par. 31).
Ignition timing incorrect.	Time engine (par. 27 a (9)).

Possible Cause	Possible Remedy
Thermostat stuck closed.	Service or replace (par. 30 c (1)).
Radiator core passages clogged.	Clean radiator core (par. 30 d).
b. Overcooling.	
Thermostat stuck open.	Service or replace (par. 30 c (1)).

30. MAINTENANCE.

a. **General.** Externally inspect cooling system components daily. After each 250 hours of operation, a detailed inspection of the components must be made.

b. **Daily Inspection.**

(1) See that radiator is full of water. Add water if necessary.

(2) When antifreeze is used, test strength with a hydrometer.

(3) Inspect all hose connections for water leaks. Tighten clamps, if necessary.

(4) Give a slight turn to grease cup on water pump. Fill, if necessary.

(5) Remove grease plug from fan, and fill fan hub with GREASE, general purpose, No. 2.

(6) Check fan belt tension, and adjust if necessary.

(7) Visually inspect radiator for leaks. Repair if leaking.

c. **Periodic Inspection.**

(1) Remove thermostat. Test its operation by placing it along with a thermometer in a pan of water. Heat the water. Measure temperature at which it opens. It should begin to open at 150 F., and should be fully opened at 180 F.

(2) Remove all radiator hose connections. Visually inspect exterior and interior. Replace if cracked, rotted, or if inside has become spongy or jelly-like.

(3) Clean cooling system. (For description of method, see TM 9-618.)

(4) If water drained from cooling system shows an unusual amount of scale and rust, the system must be reverse flushed as follows:

d. **Reverse Flush Cooling System.**

(1) RADIATOR. Remove upper and lower radiator hose from radiator. Attach a hose (long enough to conduct water to a drain) to the upper radiator inlet. Secure a length of hose to the lower radiator outlet pipe with a radiator hose clamp. Hold a reverse flushing gun (connected to water and air hose) to the other end of this hose. Turn on the water. When the radiator is full, turn on a short blast of air. Repeat the operation until water discharged from the hose attached to the upper radiator inlet pipe is clean.

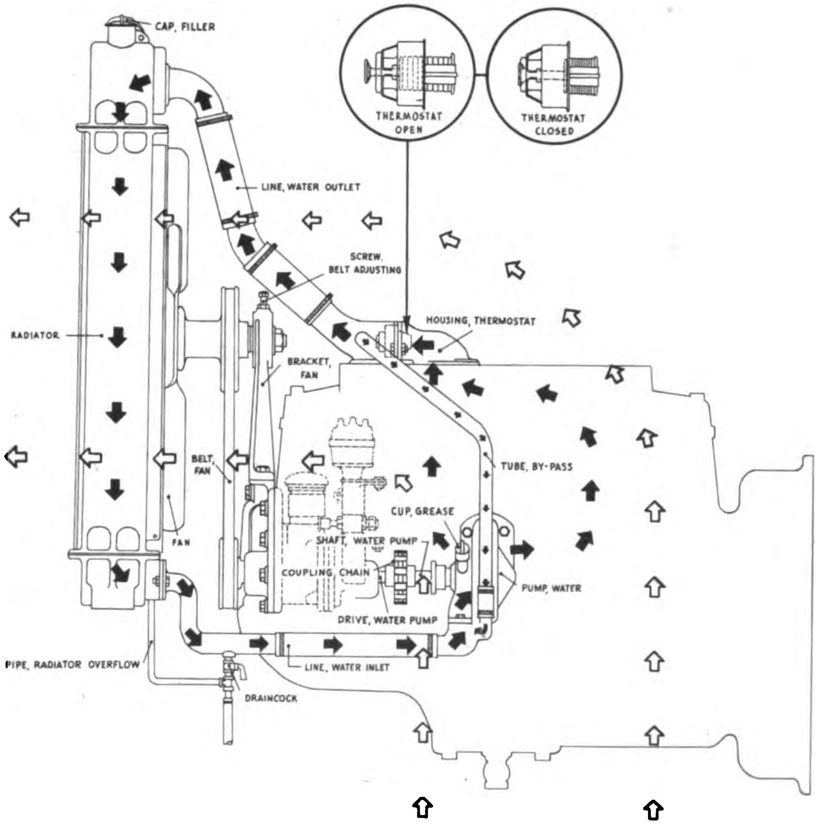

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Figure 74 — Cooling System Diagram

(2) ENGINE WATER JACKET. Remove the thermostat from the cylinder head. Cold water would cause it to close and result in building up a pressure in the system and cause damage. Remove the radiator outlet hose. Attach drain hose to water pump inlet with a radiator hose clamp. Hold reverse flushing gun to the cylinder head water outlet. Allow the water jacket to fill with water. Turn on air in short blast. Repeat process until water hose attached to water pump discharges clean water.

e. Antifreeze Cooling System.

(1) Inspect all cooling system components for leaks. If leaks are found, repair. Tighten all radiator hose connections. Tighten cylinder head cap screws to tension specified in paragraph 140. Clean and reverse flush cooling system, and add antifreeze as prescribed in TM 9-618.

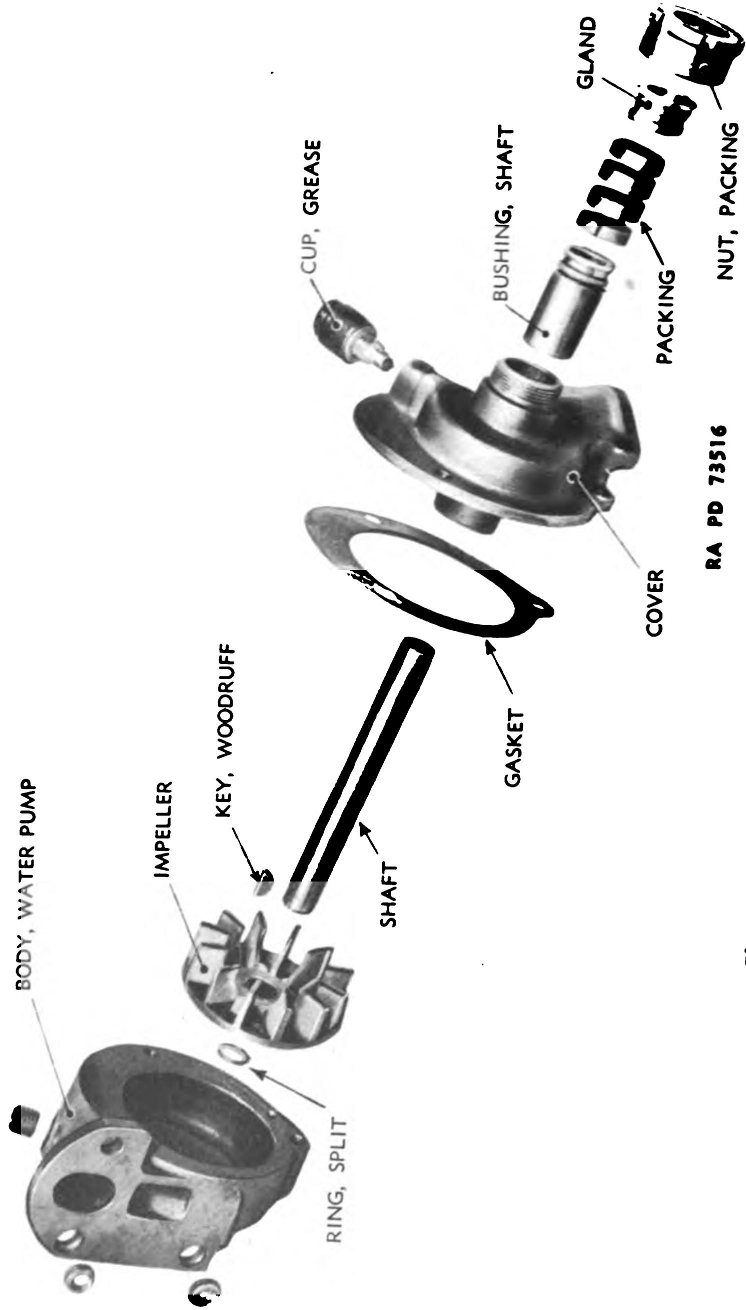

Figure 75 — Water Pump Assembly — Exploded View

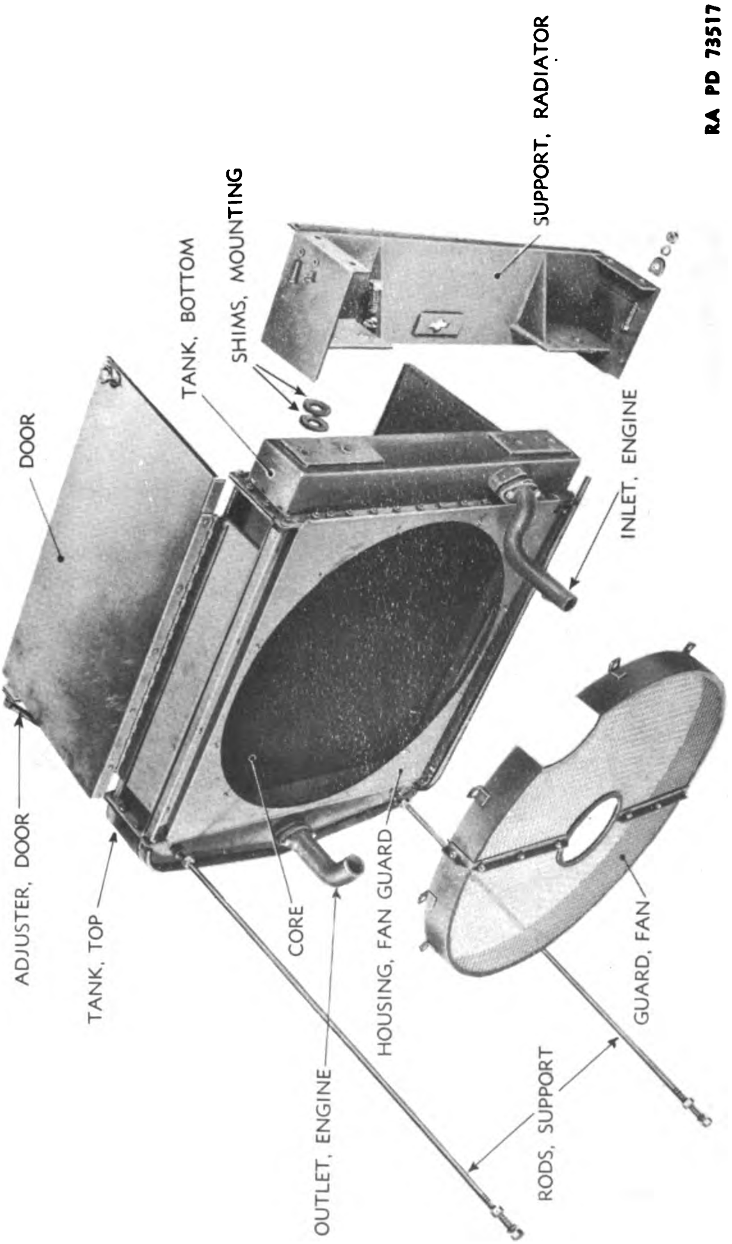

Figure 76 — Radiator and Supports Assembly

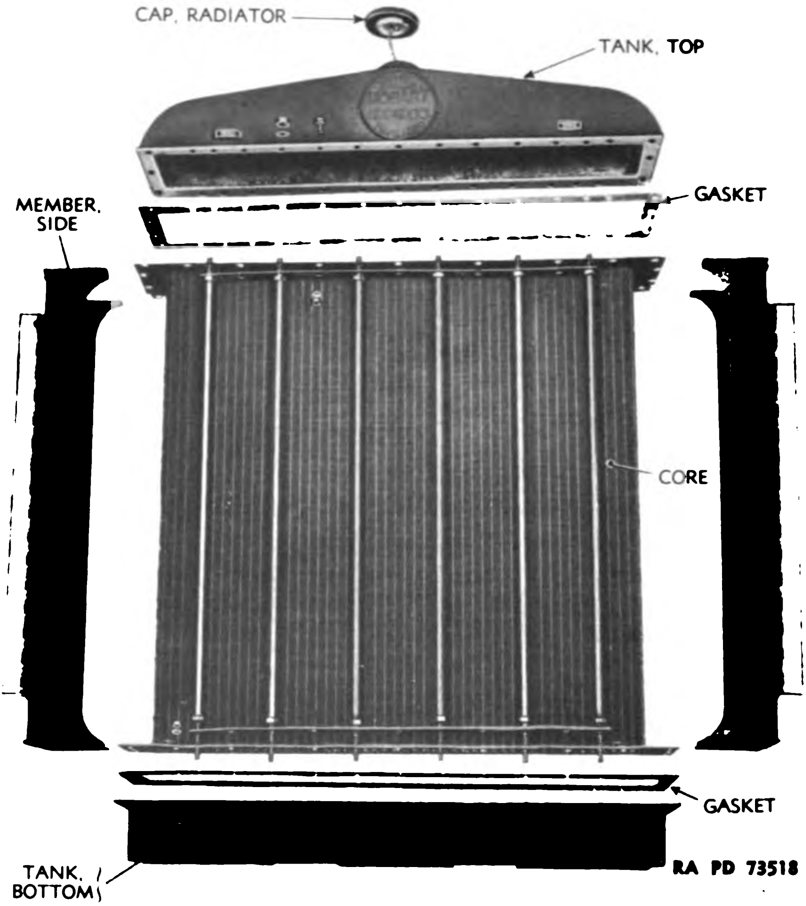

Figure 77 – Radiator Assembly

31. WATER PUMP.

a. Description. The water pump of the centrifugal-type, is on the left side of the engine, and is run by the accessory drive to which it is attached by a chain coupling. The shaft is supported on a bronze; babbitt lined bushing mounted in cover. This is lubricated through a pressure grease cup. The impeller is keyed to the pump shaft. Split ring type packing is used so that the pump can be repacked without disassembling.

b. Disassembly (fig. 75).

(1) Take out cap screws holding water pump inlet elbow to water pump and remove elbow. Remove cap screws connecting water pump cover and body. Remove cover.

(2) Loosen packing nut, remove nut, gland, and packing. Pull impeller off shaft, and remove Woodruff key. Pull shaft out of cover.

(3) Press bronze shaft bushing out of water pump cover.

c. Inspection.

(1) Clean all parts in dry-cleaning solvent, and dry with compressed air.

(2) Inspect water pump body and cover for cracks. If broken, replace or weld.

(3) Inspect water pump shaft thrust button in cover, and replace if worn.

(4) Inspect fit of water pump shaft in water pump shaft bushing, and replace bushing if worn enough to permit noticeable side play.

(5) Inspect water pump shaft for wear or damage. Replace if necessary.

d. Maintenance and Repair.

(1) Because of its construction, the water pump requires very little care, except that the grease cup must be kept filled with GREASE, water pump, and given a turn down every 8 hours to insure proper lubrication of water pump shaft bushing.

(2) In case of overhaul or repair, always use new gaskets. Replace other parts if worn or broken.

e. Assembly. This is the reverse of the procedure outlined in subparagraph b, above.

32. RADIATOR (fig. 76).

a. Description. The radiator is of the heavy-duty tractor type, and is mounted on the frame in front of the engine. Core tubes and fins are copper, and the upper tanks are cast iron. Water heated in the water jacket of the engine goes to the upper radiator tank, flows down the radiator tubes for cooling, and from there is drawn into the pump. Air drawn through louvers and up through the frame by the action of the fan, passes across the engine, and is forced out of the unit through the radiator fins, thereby cooling the water. On the top of the engine, at the point where the water returns to the radiator, is the thermostat whose function is to keep cool water from entering the radiator, and forces it to return directly to the pump through the bypass pipe until the engine is warmed up.

b. Removal.

(1) Open draincock in radiator outlet pipe. This will drain the cooling system. At point where copper radiator overflow pipe enters compression fitting below draincock, hold fitting, unscrew nut, and pull out pipe.

(2) Disconnect the fan guard sections by removing the attaching bolts and nuts. Take off square nuts attaching the two guard sections to the housing, and remove guard.

(3) Loosen metal straps binding two hose sections in upper radiator water line and one hose section in lower radiatoı line by loosening bolts. Work off hose sections.

(4) Take out cap screws and nuts holding housing roof to radiator. Remove bottom cap screw and nut at each side of radiator holding side panels to radiator.

(5) Remove nut which secures each radiator support rod to center bow by holding rod with pliers while unscrewing nuts at bow. Unscrew rod from radiator, and remove.

(6) Free radiator from frame by removing four cap screws holding radiator to frame. Remove radiator.

c. Inspection and Repair.

(1) Take out round-head machine screws and lock washers at back of radiator attaching guard to radiator. Remove guard.

(2) See that radiator filler cap fits down tightly over filler cap hole. If cap is not tight, bend top holding clamp wire to make a better fit.

(3) Visually inspect tanks and core for dents, breaks, or cracks. Weld cracks or breaks. Remove tank dents after disassembly.

(4) Inspect radiator core for leaks. Plug overflow tube, lower tank pipe, and radiator filler opening. Insert an air inlet plug in upper tank opening, and apply 3 pound air pressure in radiator core. Immerse core in tank of water. Mark places where air bubbles out of core. Solder leaks. Repeat inspection, again mark, and solder leaks, if any. CAUTION: Not more than 3 pounds air pressure should be used.

d. Disassembly (fig. 77).

(1) Take out cap screws holding radiator outlet and inlet pipe flanges to back of radiator, and remove pipes.

(2) Take out cap screws and nuts holding top tank flange to core flange. Remove nuts holding front radiator rods to radiator top tank flanges. Separate top tank from core, and remove gasket. Make sure copper overflow line from tank is free and clear.

(3) Take out cap screws and nuts holding core flange to bottom tank flange. Remove nuts holding front radiator rods to radiator bottom tank flanges. Remove core and gasket from bottom tank.

e. Assembly (fig. 77).

(1) Install front radiator rods in place between top and bottom core flanges. Set core upon lower radiator tank over a new gasket. Install nuts on ends of radiator rods projecting through lower tank flange. Install cap screws and nuts to clamp tank and core flanges together.

A — BRACKET
B — WASHER, CLAMP - FRONT
C — SPINDLE
D — NUT, HEX.
E — NUT, HEX.
F — SCREW, ADJUSTING
G — WIRE, LOCK
H — BEARING, REAR
J — SEAL, GREASE
K — WASHER, CLAMP - REAR
L — HUB
M — BLADE ASSEMBLY
N — PLUG, GREASE
P — GASKET, CORK
Q — SCREW, CAP
R — BEARING, FRONT
S — WASHER
T — NUT, CASTLE

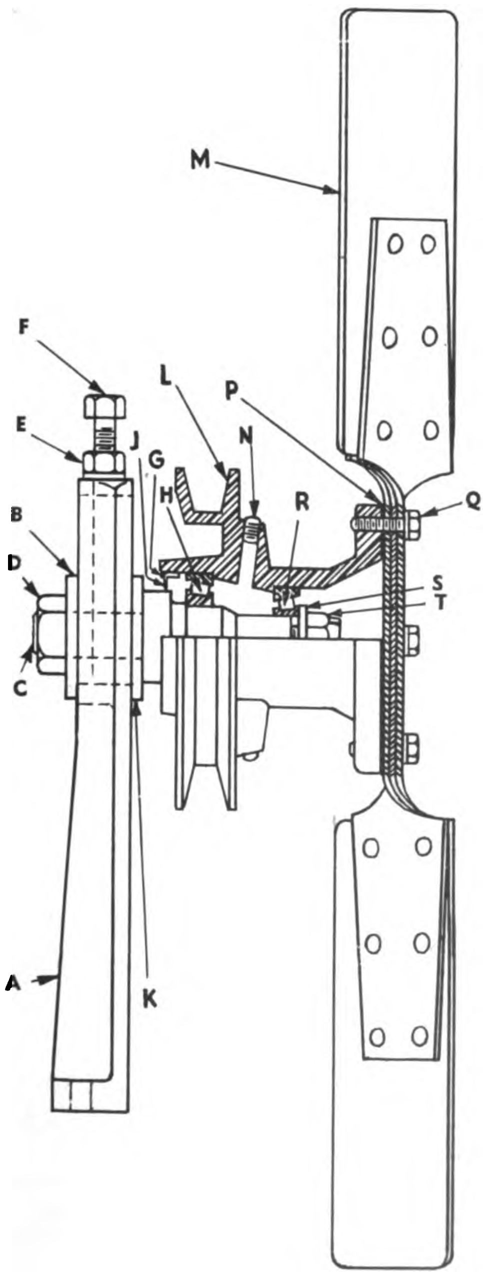

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Figure 78 — Fan and Bracket Assembly

(2) Disconnect the fan guard sections by removing the attaching bolts and nuts. Take off square nuts attaching the two guard sections to the housing, and remove guard.

(3) Loosen metal straps binding two hose sections in upper radiator water line and one hose section in lower radiatoı line by loosening bolts. Work off hose sections.

(4) Take out cap screws and nuts holding housing roof to radiator. Remove bottom cap screw and nut at each side of radiator holding side panels to radiator.

(5) Remove nut which secures each radiator support rod to center bow by holding rod with pliers while unscrewing nuts at bow. Unscrew rod from radiator, and remove.

(6) Free radiator from frame by removing four cap screws holding radiator to frame. Remove radiator.

c. **Inspection and Repair.**

(1) Take out round-head machine screws and lock washers at back of radiator attaching guard to radiator. Remove guard.

(2) See that radiator filler cap fits down tightly over filler cap hole. If cap is not tight, bend top holding clamp wire to make a better fit.

(3) Visually inspect tanks and core for dents, breaks, or cracks. Weld cracks or breaks. Remove tank dents after disassembly.

(4) Inspect radiator core for leaks. Plug overflow tube, lower tank pipe, and radiator filler opening. Insert an air inlet plug in upper tank opening, and apply 3 pound air pressure in radiator core. Immerse core in tank of water. Mark places where air bubbles out of core. Solder leaks. Repeat inspection, again mark, and solder leaks, if any. CAUTION: Not more than 3 pounds air pressure should be used.

d. **Disassembly** (fig. 77).

(1) Take out cap screws holding radiator outlet and inlet pipe flanges to back of radiator, and remove pipes.

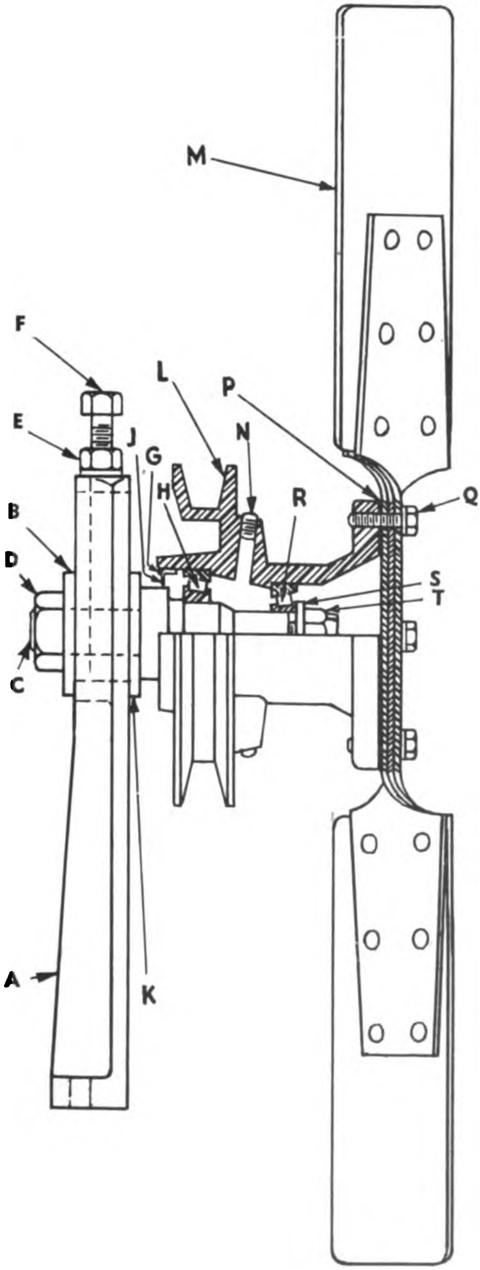
(2) Take out cap screws and nuts holding top tank flange to core flange. Remove nuts holding front radiator rods to radiator top tank flanges. Separate top tank from core, and remove gasket. Make sure copper overflow line from tank is free and clear.

(3) Take out cap screws and nuts holding core flange to bottom tank flange. Remove nuts holding front radiator rods to radiator bottom tank flanges. Remove core and gasket from bottom tank.

e. **Assembly** (fig. 77).

(1) Install front radiator rods in place between top and bottom core flanges. Set core upon lower radiator tank over a new gasket. Install nuts on ends of radiator rods projecting through lower tank flange. Install cap screws and nuts to clamp tank and core flanges together.

ENGINE AND ACCESSORIES



A — BRACKET
B — WASHER, CLAMP - FRONT
C — SPINDLE
D — NUT, HEX.
E — NUT, HEX.
F — SCREW, ADJUSTING
G — WIRE, LOCK
H — BEARING, REAR
J — SEAL, GREASE
K — WASHER, CLAMP - REAR
L — HUB
M — BLADE ASSEMBLY
N — PLUG, GREASE
P — GASKET, CORK
Q — SCREW, CAP
R — BEARING, FRONT
S — WASHER
T — NUT, CASTLE

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Figure 78 — Fan and Bracket Assembly

(2) Disconnect the fan guard sections by removing the attaching bolts and nuts. Take off square nuts attaching the two guard sections to the housing, and remove guard.

(3) Loosen metal straps binding two hose sections in upper radiator water line and one hose section in lower radiatoı line by loosening bolts. Work off hose sections.

(4) Take out cap screws and nuts holding housing roof to radiator. Remove bottom cap screw and nut at each side of radiator holding side panels to radiator.

(5) Remove nut which secures each radiator support rod to center bow by holding rod with pliers while unscrewing nuts at bow. Unscrew rod from radiator, and remove.

(6) Free radiator from frame by removing four cap screws holding radiator to frame. Remove radiator.

c. **Inspection and Repair.**

(1) Take out round-head machine screws and lock washers at back of radiator attaching guard to radiator. Remove guard.

(2) See that radiator filler cap fits down tightly over filler cap hole. If cap is not tight, bend top holding clamp wire to make a better fit.

(3) Visually inspect tanks and core for dents, breaks, or cracks. Weld cracks or breaks. Remove tank dents after disassembly.

(4) Inspect radiator core for leaks. Plug overflow tube, lower tank pipe, and radiator filler opening. Insert an air inlet plug in upper tank opening, and apply 3 pound air pressure in radiator core. Immerse core in tank of water. Mark places where air bubbles out of core. Solder leaks. Repeat inspection, again mark, and solder leaks, if any. CAUTION: Not more than 3 pounds air pressure should be used.

d. **Disassembly** (fig. 77).

(1) Take out cap screws holding radiator outlet and inlet pipe flanges to back of radiator, and remove pipes.

(2) Take out cap screws and nuts holding top tank flange to core flange. Remove nuts holding front radiator rods to radiator top tank flanges. Separate top tank from core, and remove gasket. Make sure copper overflow line from tank is free and clear.

(3) Take out cap screws and nuts holding core flange to bottom tank flange. Remove nuts holding front radiator rods to radiator bottom tank flanges. Remove core and gasket from bottom tank.

e. **Assembly** (fig. 77).

(1) Install front radiator rods in place between top and bottom core flanges. Set core upon lower radiator tank over a new gasket. Install nuts on ends of radiator rods projecting through lower tank flange. Install cap screws and nuts to clamp tank and core flanges together.

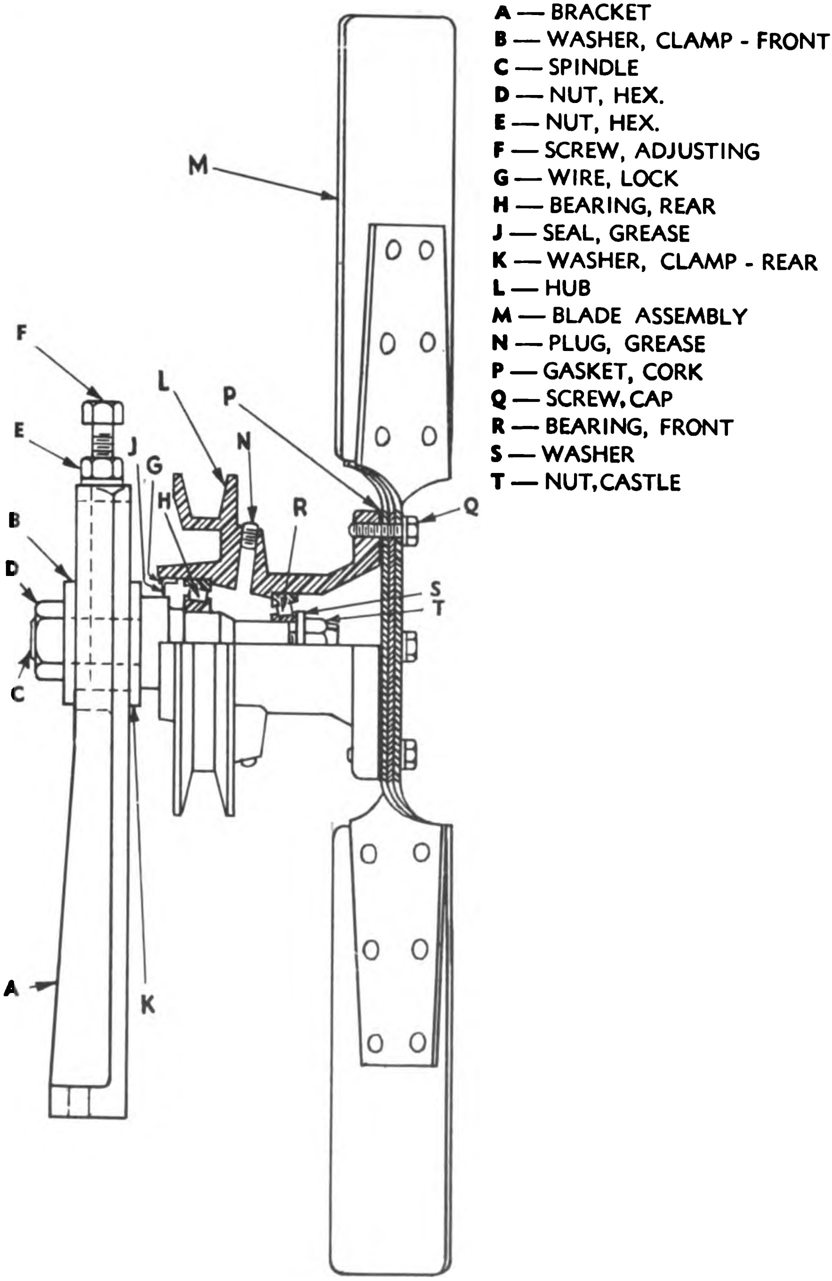

Figure 78 — Fan and Bracket Assembly

(2) Set a new gasket in place on top of the radiator core, and bring upper water tank down upon gasket and core. Secure tank to core with nuts and lock washers on front radiator rods and with cap screws and nuts through the flanges.

(3) Attach inlet and outlet pipes to radiator tanks with cap screws. If gaskets are at all mutilated or worn, replace.

(4) Attach radiator guard to rear of radiator with round-head machine screws.

f. Installation.

(1) Put shims in place on frame bracket (four over each mounting hole), set radiator in position, insert hold-down cap screws and nuts, and tighten nuts securely.

(2) Screw nut on 2⅜-inch threaded end of each radiator support rod. Insert this end of each rod through holes provided in center bow uprights. Bring rods forward to meet tapped holes in radiator, and tighten rods in radiator holes. Put nut on other end of each rod and tighten nuts against center bow uprights (fig. 11).

(3) Attach radiator to housing with cap screws through roof and radiator flange, and install nuts.

(4) Place fan guard sections in position, and secure to fan guard housing with lock washers and nuts on the projecting bolts. Install machine screws and nuts to connect the sections.

(5) Install rubber hose sections connecting engine to radiator inlet and outlet pipes, and tighten clamp bolts.

(6) Attach end of flexible drainpipe to fitting below draincock.

g. Radiator Hose. The radiator hose is of reinforced rubber. The following sizes are used:

Upper radiator hose:	
Inside diameter	2 in.
Length	4 in., 11½ in.
Lower radiator hose:	
Inside diameter	1½ in.
Length	9 in.
Drain hose:	
Inside diameter	½ in.
Length	18 in.

33. FAN (fig. 78).

a. Description. The fan, mounted on an adjustable bracket behind the radiator, is belt-driven from a pulley on the front of the accessory drive. The fan is of the pusher type, drawing the air through the unit and out through the radiator. The fan belt is V-type, ⅞ inch wide and 54 inches long. The fan roller bearings are lubricated through a grease plug in the hub.

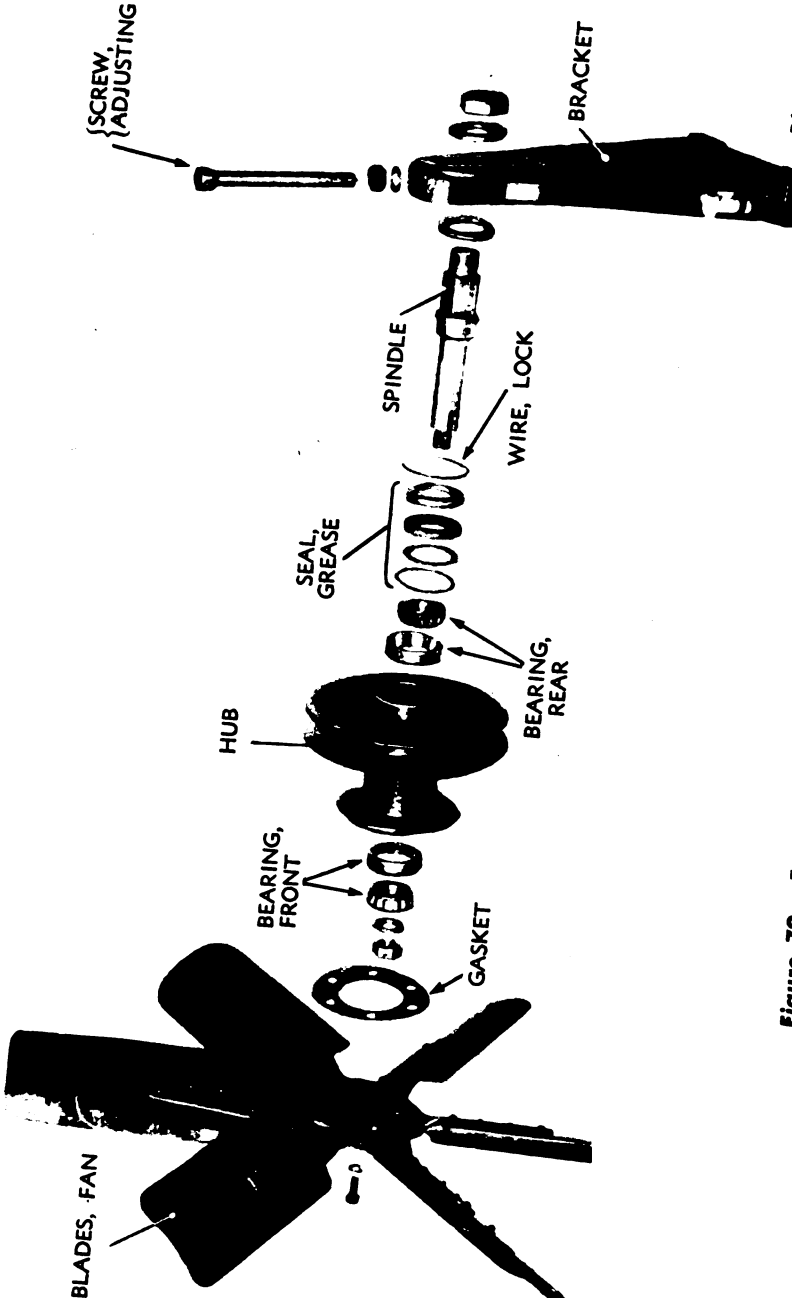

Figure 79 — Fan and Bracket Assembly — Exploded View

b. Disassembly (fig. 79).

(1) Loosen lock nut on fan belt adjusting screw. Unscrew and remove adjusting screw and nut. Take nut and washer from spindle. Remove spindle from bracket.

(2) Remove cap screws holding fan assembly to hub.

(3) Pry out bearing retainer lock wire from groove in fan hub.

(4) Pull cotter pin and remove front bearing retaining nut and washer from fan spindle.

(5) Drive spindle from front roller bearing, and remove bearing core assembly from fan hub.

(6) Slide retainer, cork washer, and washer from spindle, and then drive rear bearing core assembly from spindle.

(7) Drive out front bearing cup and rear bearing cup from fan hub.

c. Inspection.

(1) Inspect spindle threads for damage or evidence of stripping, and check fit of spindle in bearings.

(2) Check fan for loose rivets or bent blades.

(3) Inspect roller bearings and retainers for scoring wear and evidence of loose fitting.

d. Maintenance and Repair.

(1) Keep fan hub filled with lubricant at all times. If grease-lubricated, remove plug and insert fitting to lubricate fan bearings. Replace plug. If oil-lubricated, use hand oiler.

(2) Replace all worn parts.

(3) Tighten loose fan rivets. Carefully straighten bent fan blades. If blades are badly bent, replace fan.

e. Assembly (fig. 79).

(1) Insert front and rear bearing cups and drive them in until they bottom against shoulder. Pack bearing cups and bearings with GREASE, general purpose, No. 2, and place bearings in cups if fan is grease-lubricated.

(2) In order named, install gasket, plain washer, and retainer in fan hub, back of rear bearing.

(3) Secure oil seal washer retainer lock wire in fan hub recess.

(4) Insert spindle in fan hub and replace washer, castellated nut, and cotter pin.

(5) Place fan blade assembly with gasket on fan hub, and install fan cap screws.

(6) Insert fan and hub assembly through slotted washer into slot in mounting bracket, and replace washer and spindle nut.

(7) Install fan adjusting screw with lock nut in top bracket, and thread screw into spindle.

(8) Remove oil plug in fan hub and fill with OIL, engine (seasonal grade), if fan is oil-lubricated.

ENGINE AND ACCESSORIES

Section III

FUEL SYSTEM

Paragraph

34. FUEL SYSTEM DESCRIPTION (fig. 80).

a. The fuel system consists of the fuel tank, fuel pump, carburetor, air filter, intake manifold, governor, throttle and choke controls, and fuel and drain lines.

b. Suction action of the fuel pump takes the fuel from the tank to the pump, which then forces it to the top of the carburetor where it is mixed with the intake air to form a vapor. Suction of the engine pistons pulls air through the air filter into the carburetor where it picks up fuel vapor. The same action carries the vapor along to the intake section of the manifold.

c. The governor, operated from the timing gear, is set to hold the engine at a predetermined speed. The choke, operated manually from the instrument panel, regulates the air supply which makes the mixture rich or lean. The throttle, also operated from the instrument panel, reduces the amount of vapor supplied to the engine.

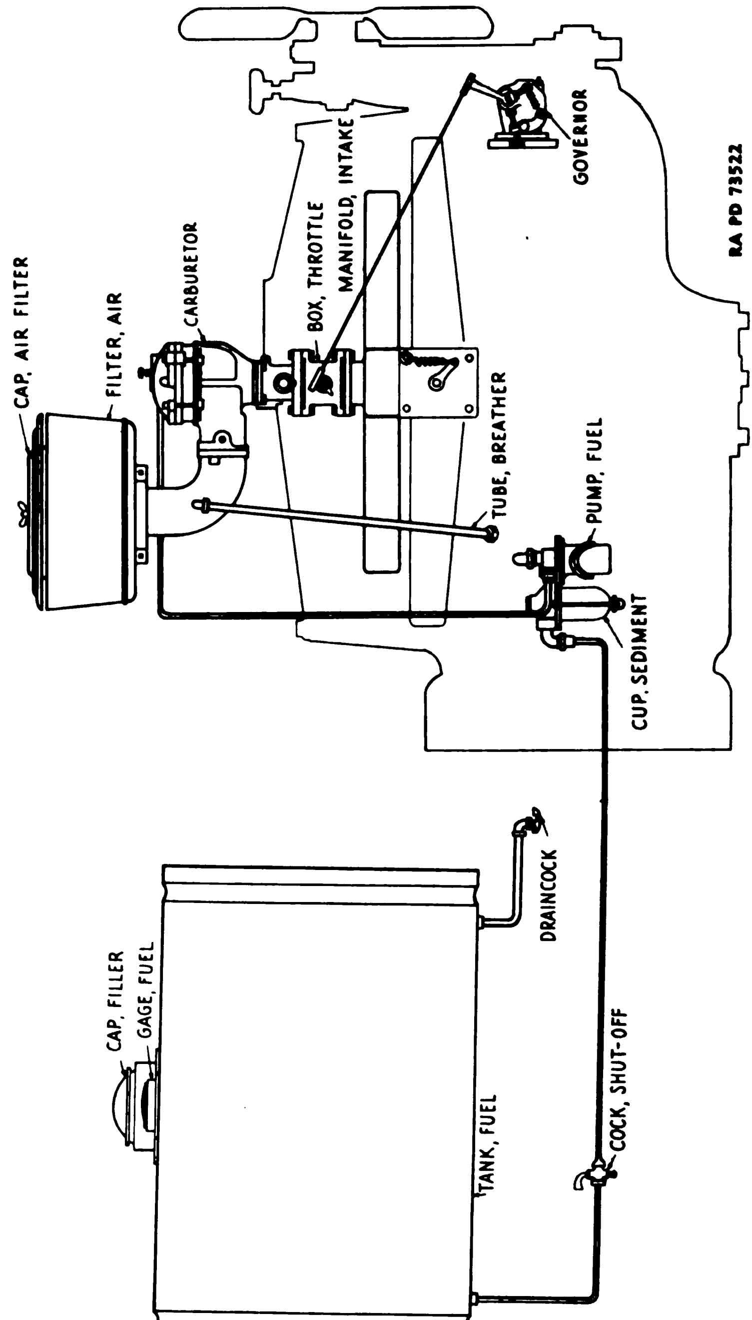

Figure 80 — Fuel System

35. FUEL SYSTEM TROUBLE SHOOTING.

a. Fuel Pump.

Possible Cause	Possible Remedy
(1) FUEL LEAKS.	
Loose sediment cup.	Tighten cup bracket nut.
Faulty sediment cup gasket.	Replace gasket.
Loose fuel line fittings.	Tighten fuel pump inlet and outlet fittings. Replace, if threads are stripped.
Broken fuel pump diaphragm.	Replace diaphragm.
Stuck valve.	Free up or replace valve or valve spring.
(2) LOW FUEL PRESSURE.	
Air leaks in system.	Tighten connections.
Diaphragm out of order.	Replace diaphragm.
Stuck valve.	Free up, or replace valve or valve spring.
Broken lever or diaphragm spring.	Replace spring.

b. Carburetor.

Possible Cause	Possible Remedy
(1) RICH MIXTURE.	
Carburetor choke not fully opened.	Free up valve shaft and lubricate. Adjust choke control.
Dirt in carburetor.	Disassemble and clean.
(2) ENGINE DIES.	
Engine will not idle.	Adjust idling screw.
(3) FAST IDLING.	
Improper control adjustment.	Adjust throttle control button and throttle stop screw.
Carburetor throttle.	Free up shaft and linkage and lubricate.
Carburetor controls sticking.	Free up and lubricate.
Air leaks.	Check intake manifold and carburetor gasket.
(4) LACK OF FUEL.	
Empty fuel tank.	Fill tank with fuel.
Bent or kinked tubing.	Straighten or replace tubing.

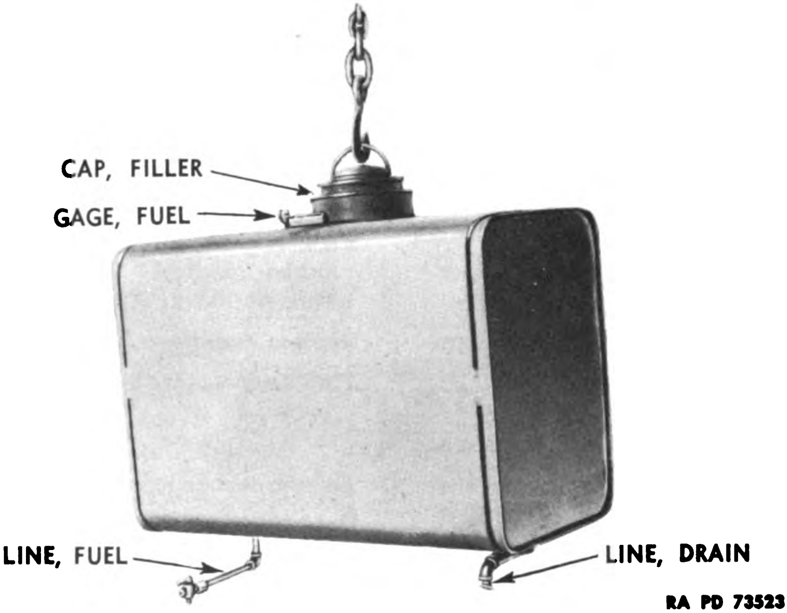

Figure 81 — Fuel Tank

Possible Cause	Possible Remedy
Sticking fuel valve in carburetor.	Replace fuel valve and seat.
Faulty fuel pump.	Repair or replace fuel pump.

(5) EXCESSIVE FUEL CONSUMPTION.

Improper carburetor adjustment.	Adjust float level, idling screw, and throttle control stop screw.
Dirty air cleaner.	Clean air cleaner filter in SOLVENT, dry-cleaning. Change cleaner oil bath.

(6) FUEL LEAKS AT CARBURETOR.

Loose body bolts or worn gaskets.	Tighten bolts, and replace gaskets.
Worn float needle valve.	Replace float needle valve and float needle valve seat.
Cracked float.	Replace float.
Choke valve stuck closed.	Free choke valve.
Choke lever loose on shaft and valve closed.	Open valve and tighten choke lever clamp screw.

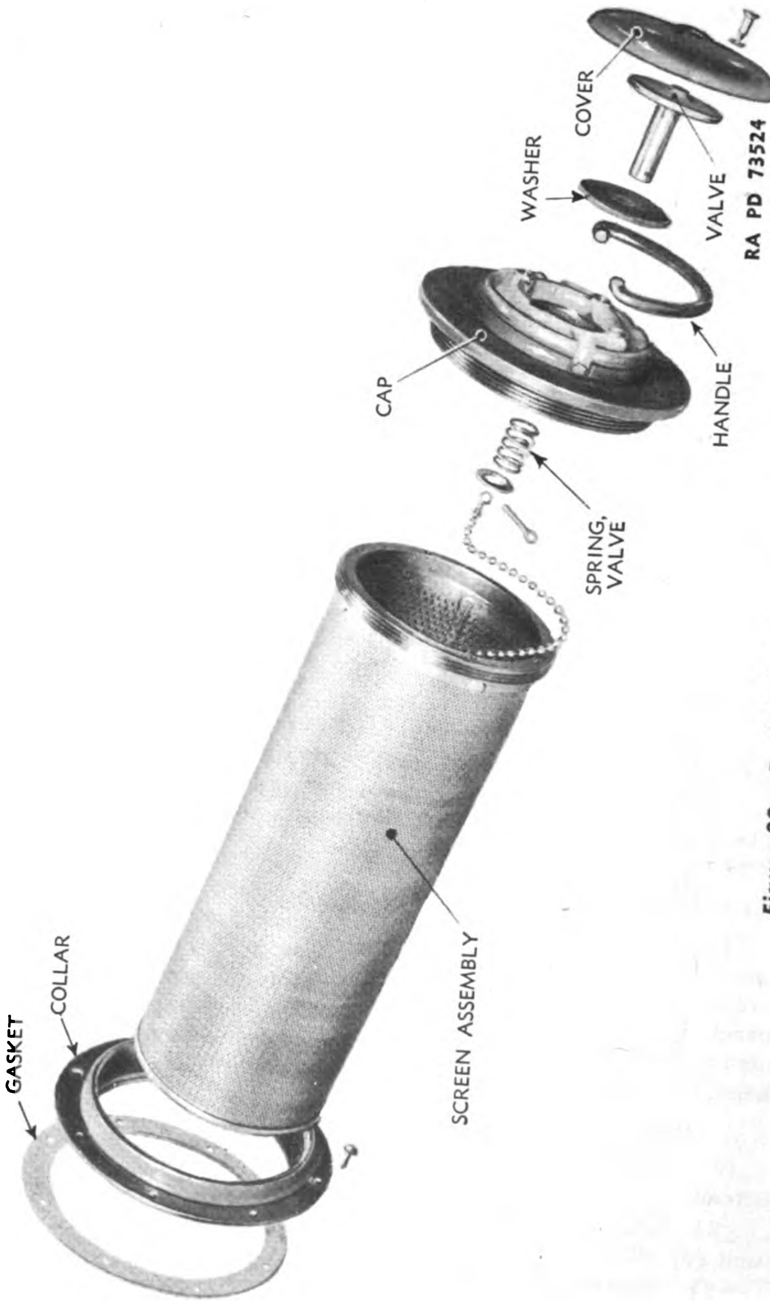

Figure 82 — Fuel Tank Filler Cap Assembly

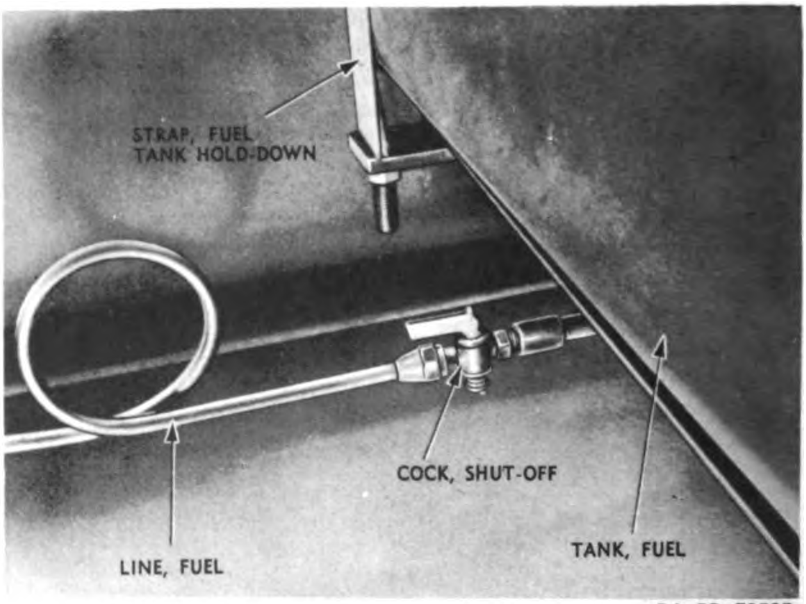

Figure 83 — Fuel Line at Tank, Showing Shut-off Cock

36. FUEL TANK (fig. 81).

a. **Description.** The fuel tank is located at the rear of the unit, enclosed by a sheet metal guard. The fuel line feeds from a bottom pipe tap on the right-hand side. A short drain line ending with a drain-cock is placed opposite. A filler cap is provided with a special flame arrester screen (fig. 82).

b. **Removal.**

(1) Close shut-off cock on fuel line under fuel tank (fig. 83). Uncouple nut on engine side of cock, and disconnect line.

(2) Remove cap screws and nuts holding guard to rear housing panel. Remove cap screws and nuts holding guard to frame. Remove nuts from strap-end bolts attaching tank straps to frame cross member behind rear panel (fig. 86). Lift guard up and off. Remove tank.

c. **Disassembly.**

(1) Unscrew and remove filler cap. Unscrew and remove filler cap screen.

(2) Take out screws holding gage unit to tank and remove gage unit (fig. 85).

(3) Unscrew and remove drain line and fuel line connecting into base of fuel tank.

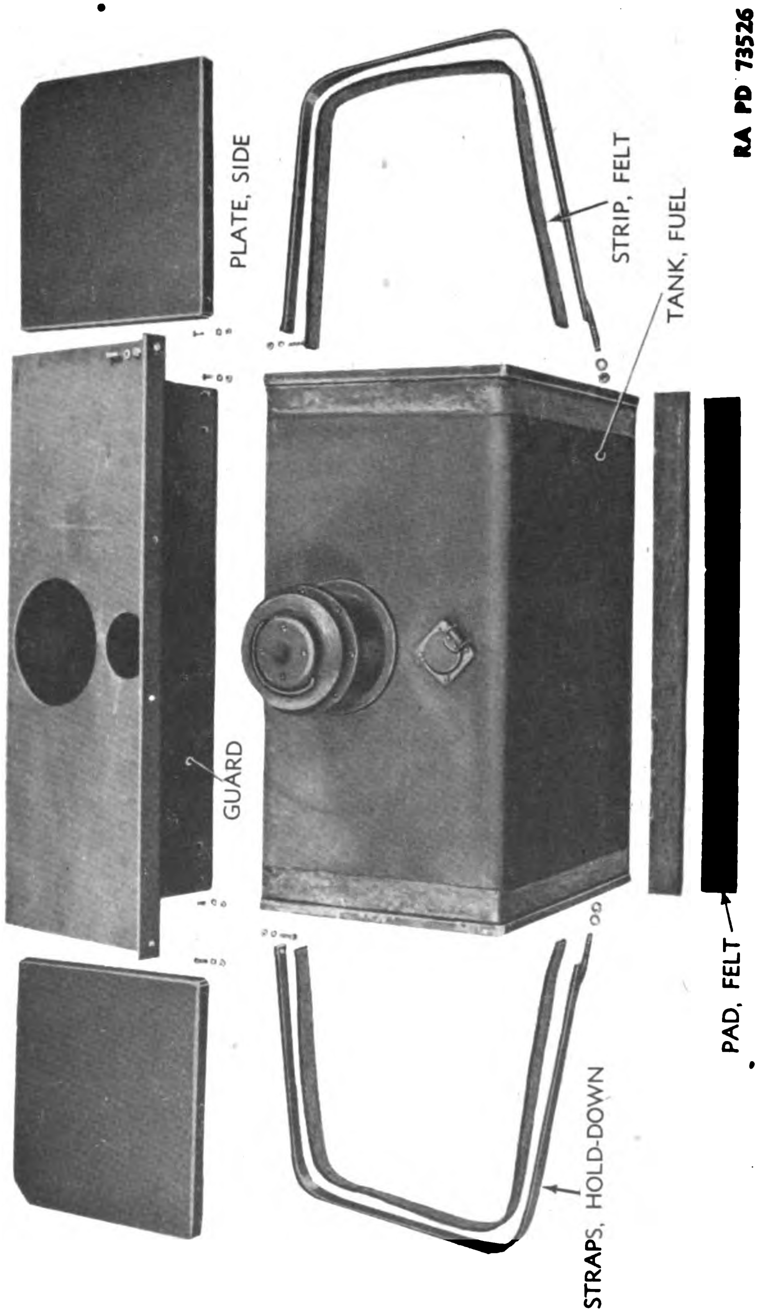

Figure 84 — Fuel Tank and Mounting Details

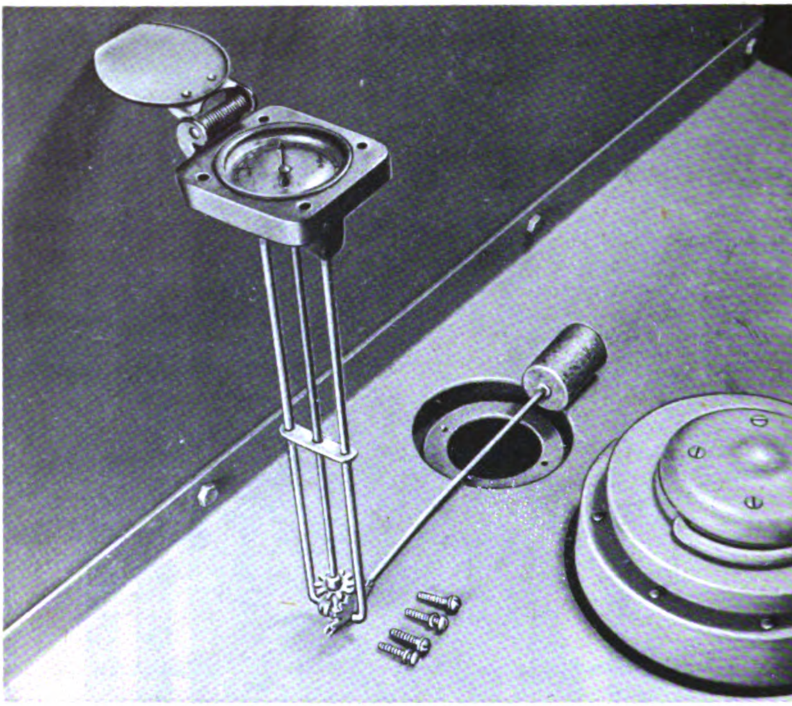

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Figure 85 — Fuel Gage — Mechanical Type

d. **Cleaning.** Before attempting to repair any fuel tank, clean the tank thoroughly. This is absolutely necessary as a safety precaution against the explosion of gasoline or fumes remaining in the tank. The usual procedure is to fill the tank with a solution containing an alkaline cleaner (Q.M.C. Tentative Specifications ES-No. 542), and then flush it out with steam. While flushing, keep all the fittings open to drain the sediment and to avoid building up a steam pressure high enough to weaken or wreck the tank.

e. **Testing.** Fuel tanks are tested for leaks by either the wet or the air pressure method.

(1) The wet method is as follows:

(a) Tightly plug all openings except the filler neck.

(b) Dry the entire outer surface of the tank thoroughly with compressed air and a clean rag.

(c) Place the tank on a bench on top of blocks so that the under side can easily be seen with the aid of an electric light.

(d) Fill the tank with water.

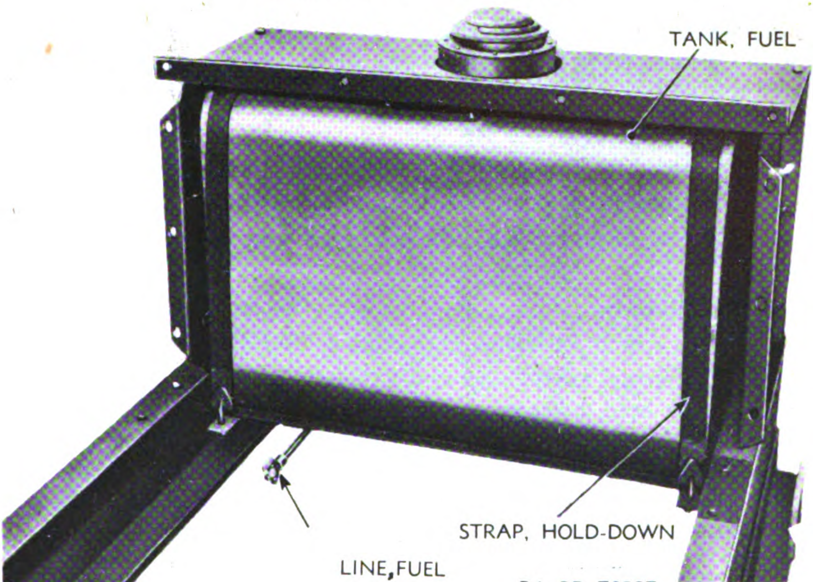


Figure 86 — Fuel Tank on Unit, Showing Hold-down Straps

(e) Insert the end of the air hose in the filler neck and cover the rest of the opening with the palm of the hand.

(f) Apply air pressure against the water by opening the air valve with the other hand for a few minutes.

(g) Examine the entire tank for moist spots where the water was forced through.

(2) The air pressure method is as follows:

(a) Plug all openings except the fuel outlet connection.

(b) Attach the loose end of the air supply hose to the fuel outlet connection by a short-threaded tube.

(c) Submerge the fuel tank in a tank of clean water, or cover it with a tank of soapy water.

(d) Turn on the air pressure, *not more than 5 pounds.*

(e) Draw a ring around each spot on the fuel tank where bubbles appear. The bubbles indicate leaks.

f. Repairing. The repair of fuel tanks is a soldering copper job, *not* a torch job, because of the danger of an explosion when an open flame is used. The soldering copper is safe and fast enough, if skillfully used. *Never use a torch.* If there are leaks about a fitting, remove the fitting, and clean and re-tin the joint before re-soldering the fitting to the tank. Use half-and-half solder. Holes in gas tanks can be repaired

by soldering a patch over the hole. Thoroughly clean and tin the section of the tank to be patched, tin one surface of the patch, and solder patch to fuel tank with tinned surface of patch against tank.

g. **Assembly.**

(1) Screw fuel and drain pipes into collars at bottom of tank.

(2) Set gage in position, and attach with screws.

(3) Screw filler cap screen into collar, and then screw cap into place.

h. **Installation.**

(1) Place tank on frame, and connect fuel line.

(2) Bring fuel tank guard down over fuel tank, at the same time carrying tank hold down straps down under frame rear panel to holes provided for tank strap end bolts in frame rear cross member (fig. 86). Insert bolts and adjust nuts to hold straps firmly in place. Install cap screws and nuts to attach guard to frame. Install cap screws and nuts to attach guard end panel.

37. FUEL PUMP.

NOTE: Figures in parentheses correspond to those on figure 87.

a. **Description.**

(1) The fuel pump is a mechanical, diaphragm-type which is attached to the crankcase and operated by an eccentric on the engine camshaft.

(2) Diagram 1, figure 87 shows the action of drawing fuel from the fuel tank to the pump. The action of the eccentric cam (A) on the rocker arm (B) carries the end of bar (E) down, and with it the diaphragm (D). Suction action of the diaphragm opens the intake valve (H) over the sediment bowl (K), and draws fuel up through the valve and into the space created by the distended diaphragm. A half revolution of the camshaft, as shown in diagram 2, allows the lever (B) to fall back, releasing pressure on bar (E). The diaphragm spring (F) is released from compression, and pushes the diaphragm up in the pressure stroke. The pressure of the diaphragm forces the fuel through outlet valve (J).

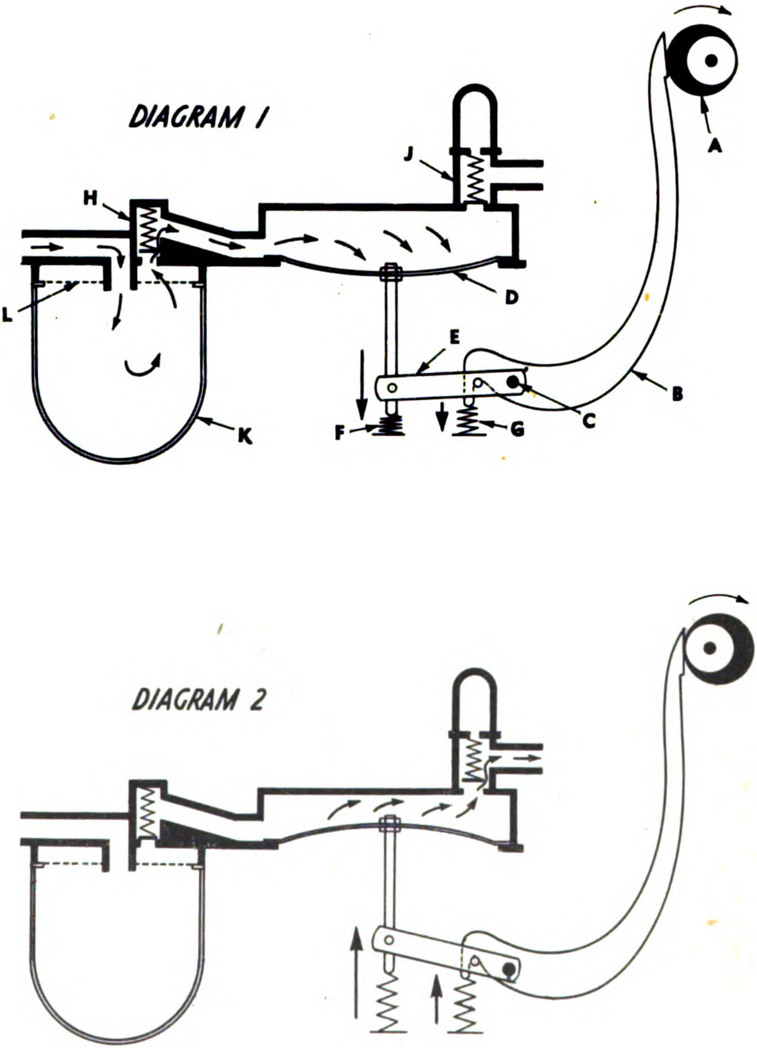
b. **Disassembly** (fig. 88).

(1) Loosen holding screw at bottom of sediment cup, swing out holding bracket and remove cup, gasket, and strainer.

(2) Take out screws holding bottom cover to pump body.

(3) Unscrew valve cap nuts, and remove valve springs and valves.

(4) Take out screws holding cover to pump body, and remove cover. Remove nuts holding diaphragm to push rod, and take off diaphragm.



A — CAM
B — ARM, ROCKER
C — PIVOT, ROCKER ARM
D — DIAPHRAGM
E — BAR

F — SPRING, DIAPHRAGM
G — SPRING, ROCKER ARM
H — VALVE, INTAKE
J — VALVE, OUTLET
K — BOWL, SEDIMENT
L — STRAINER, FUEL

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Figure 87 — Fuel Pump Action Diagrams

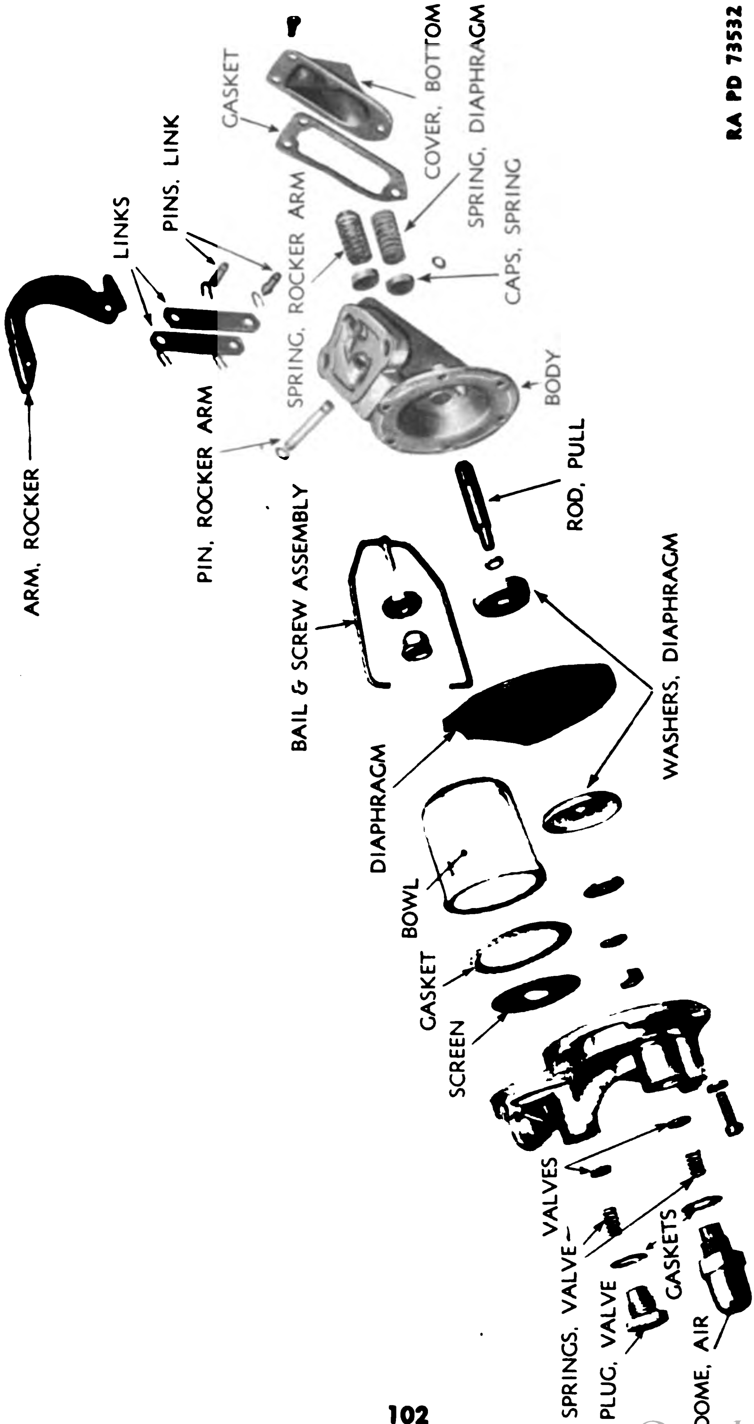


Figure 88 — Fuel Pump Assembly — Exploded View

c. **Inspection.** After the pump has been disassembled, it should be cleaned, and parts inspected.

(1) Replace all parts that show signs of wear or damage causing the pump to operate unsatisfactorily.

(2) Patricularly note condition of diaphragm, and inspect inlet and outlet valves to make sure they are clean, and that springs seat valves properly.

d. **Maintenance and Repair.**

(1) MAINTENANCE.

(a) Examine pump and connections daily for leaks.

(b) Remove valve cap nuts at frequent intervals, and clean springs and valves.

(c) Remove, empty, and clean sediment cup.

(d) Remove and clean strainer and strainer gasket.

(e) Check tightness of bolts and screws.

(2) Repairs to pump are a matter of replacing defective parts.

e. **Assembly.** This procedure is the reverse of the procedure outlined in subparagraph b, above.

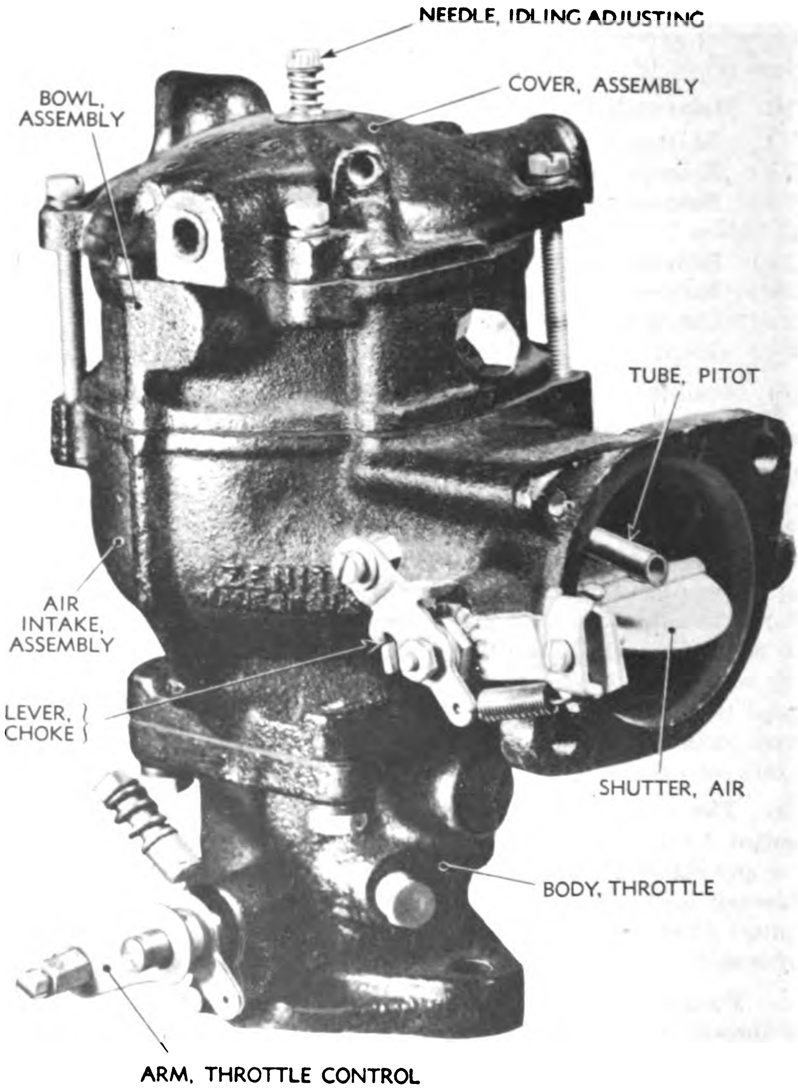
38. CARBURETOR DESCRIPTION (figs. 89, 90, and 91).

NOTE: Numbers and figures in parentheses correspond to those on figures 90 and 91.

a. The carburetor is of the downdraft-type. It employs a secondary Venturi to aid in complete vaporization of fuel. All air for fuel chamber ventilation and idling must come through the air filter, and air filter restrictions have a minimum influence on fuel-air ratio. It is designed with a vacuum controlled power jet and accelerating system. These auxiliary jet systems are to provide the extra fuel needed for certain operations.

b. The main discharge tube is centrally located directly above the Venturi. A metering well surrounds the upper portion of the discharge tube and is in the center of the fuel bowl. This concentration permits extremely high-angle operation in any direction. The removable double Venturi (19) measures the volume of air which passes through the carburetor.

c. Fuel, under normal fuel pump pressure, entering the float chamber through the fuel valve seat (11), is controlled by the float (14) which, moving on its axle (13), closes the needle valve (10) when the fuel reaches the proper level. At idling speeds, the throttle plate is almost closed, creating high suction at the edge of the plate. At this point the priming plug, or idle discharge orifice, is located. All fuel for part-throttle operation is ordinarily supplied through the main jet. In some cases this is supplemented by a bypass in the power jet valve.



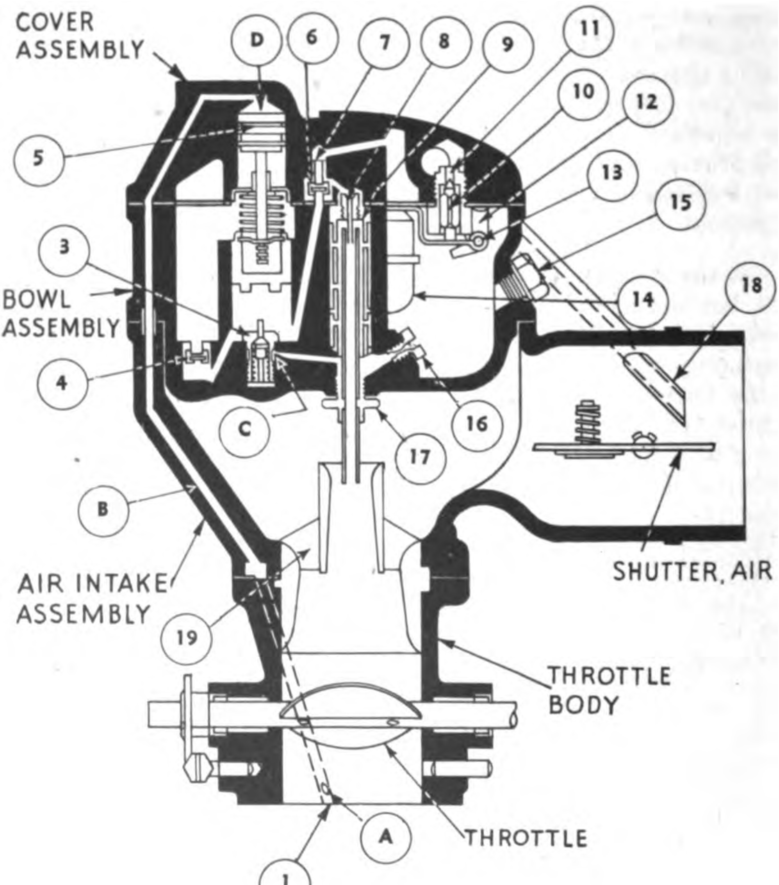
RA PD 73533

Figure 89 — Carburetor

Fuel from the float chamber floats through the main jet (16) into the metering well (9). Fuel for idling is drawn from this well through the metering orifice in the lower end of the idling jet (22). As fuel reaches the idling channel (E), it is mixed with air admitted from air intake channel (G) through permanent bleed (F), plus that admitted by the idling adjusting needle (23). The mixture passes through channel (E) to priming plug (20), at which point it is discharged into the air stream. Permanent bleed (F) prevents fuel from being siphoned into the manifold.

d. As the throttle is opened, the suction at the priming plug diminishes, but the increased volume of air entering the engine creates sufficient vacuum in the secondary Venturi (19) to draw fuel from the metering well (9) up and over into the discharge tube (17). Air from the float chamber, which is vented through a channel to the pitot tube (18) in the air intake, is admitted to the outer side of the metering well through the well vent (21). The manifold vacuum is communicated through opening (A) and channel (B) to the vacuum cylinder (D). Under normal part-throttle operating conditions, the vacuum piston and pump assembly (5) is held in the upper position as illustrated, and the power jet valve (3) is closed. When the throttle is opened wide, or when the load on the engine is increased to a point where the manifold vacuum drops below a predetermined point, the pump assembly drops, and holds the power jet valve (3) open. This permits fuel to flow through the power jet calibration (C) to supplement the main jet fuel in the well and provide a full power mixture. When the throttle position allows the manifold vacuum to rise above a predetermined point, the pump assembly is lifted and the power jet valve closed, permitting the carburetor to deliver an economy mixture again.

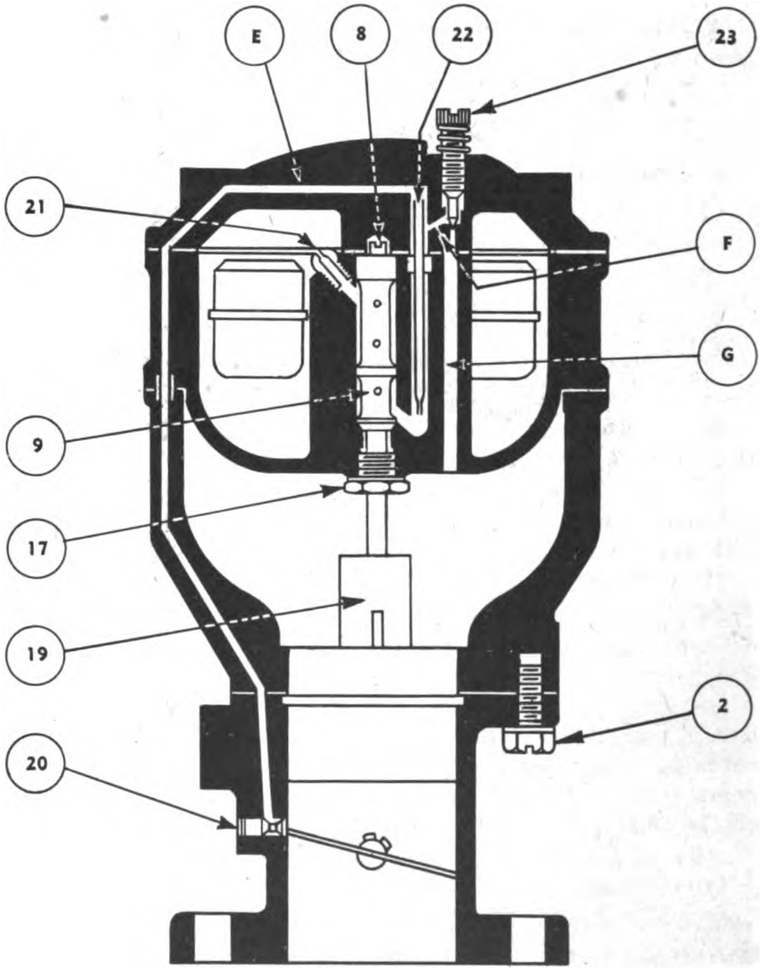
e. Quick opening of the throttle produces a sudden drop in the manifold vacuum, which allows the pump piston to be forced down by the pump spring. The downward movement of the piston closes pump check valve (4), opens refill check valve (6), closes air vent check valve (7), and discharges pump fuel through accelerating jet (8) into main discharge tube (17). When the pump stroke is completed, the air vent valve disk drops, opening air vent (7) and closing pump refill valve (6). Pump check valve (4) also opens (by gravity) to permit fuel to flow to the power jet or to refill the pump cylinder on the upward stroke of the pump. The air vent (7) supplies air from the float chamber to the accelerating jet to break suction on the accelerating and power jet system when the vacuum piston starts to lift the pump assembly.



A — MANIFOLD VACUUM OPENING
B — MANIFOLD VACUUM CHANNEL
C — POWER JET CALIBRATION
D — CYLINDER, VACUUM
1 — CHANNEL, BY-PASS
3 — VALVE, POWER JET
4 — PUMP CHECK VALVE
5 — VACUUM PISTON AND PUMP ASSEMBLY
6 — VALVE, REFILL CHECK
7 — VALVE, AIR VENT CHECK
8 — JET, ACCELERATING
9 — WELL, METERING
10 — VALVE, NEEDLE
11 — SEAT, FUEL VALVE
12 — BRACKET, FLOAT HINGE
13 — AXLE, FLOAT
14 — FLOAT
15 — PLUG, BOWL ACCESS
16 — JET, MAIN
17 — TUBE, MAIN DISCHARGE
18 — TUBE, PITOT
19 — VENTURI, REMOVABLE DOUBLE

RA PD 73534

Figure 90 — Carburetor, Diagram 1



E — IDLING CHANNEL
F — PERMANENT BLEED
G — AIR INTAKE CHANNEL
2 — SCREW, AIR INTAKE TO THROTTLE BODY
8 — JET, ACCELERATING
9 — WELL, METERING
17 — TUBE, MAIN DISCHARGE
19 — VENTURI, REMOVABLE DOUBLE
20 — PLUG, PRIMING
21 — VENT, WELL
22 — JET, IDLING
23 — NEEDLE, IDLING ADJUSTING

RA PD 73535

Figure 91 — Carburetor, Diagram 2

39. CARBURETOR DISASSEMBLY.

NOTE: The following special tools are required for complete disassembly:

Tool No. C161-5, Zenith. Tool No. 161-123, Zenith.

Tool No. 161-121, Zenith.

a. Procedure.

(1) Unscrew idling adjusting screw at top of carburetor, and remove screw and spring.

(2) Take out the two long outside screws holding the bowl to the air intake assembly. Remove bowl (fig. 92), turn upside down, and take off gasket.

(3) Unscrew discharge tube, and remove tube and gasket (fig. 93).

(4) Turn the bowl right side up and remove the two short screws that hold the cover to the bowl, and remove cover and gasket.

(5) Lift pump assembly out of cover (fig. 94).

(6) Push float axle through the slotted end of the hinge bracket, and remove. Take out float assembly and fuel valve needle (fig. 95).

(7) Unscrew fuel valve seat, and remove seat and gasket.

(8) Insert tapered thread end of tool C161-5 into the valve body and screw in (counterclockwise) until tool is firmly attached to the body, then raise the sliding weight up sharply against the stop bar a few times to remove the port. Be careful to avoid screwing the tool too deeply into the valve body as it may damage the air vent check valve seat that is pressed into the cover directly above this point. If the hole in the valve body becomes enlarged, grind a little off the end of the tool so it will start to grip the body sooner.

(9) Lift idling jet out of the bowl casting (fig. 96).

(10) Unscrew well vent from the bowl casting, and remove.

(11) Remove metering well and accelerating jet. Unscrew accelerating jet from metering well (fig. 97).

(12) Carefully center tool C161-121 on valve head, and remove power jet valve and gasket.

(13) Unscrew bowl plug, and remove.

(14) Insert screwdriver through hole where plug was removed, loosen main jet, and remove (fig. 98).

(15) Insert taper thread end of tool C161-123 into the valve and screw in (counterclockwise) until the tool is firmly attached to the valve body, then strike the bent end with a hammer squarely and sharply a few times to pull the valve out. If tool pushes the valve disk out, be sure the disk is not left in the carburetor channel.

(16) Turn assembly upside down, remove cap screws connecting throttle body and air intake chamber. Remove throttle body (fig. 99).

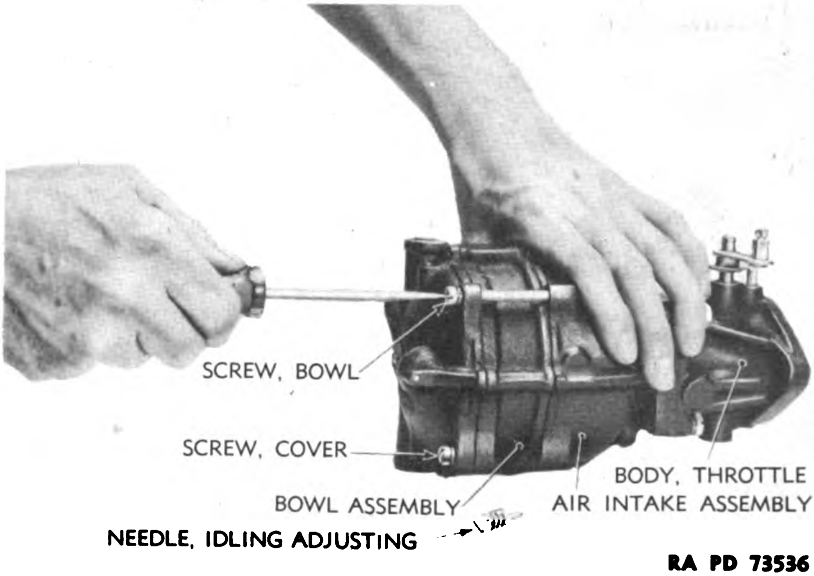


Figure 92 — Carburetor Bowl Assembly Removal

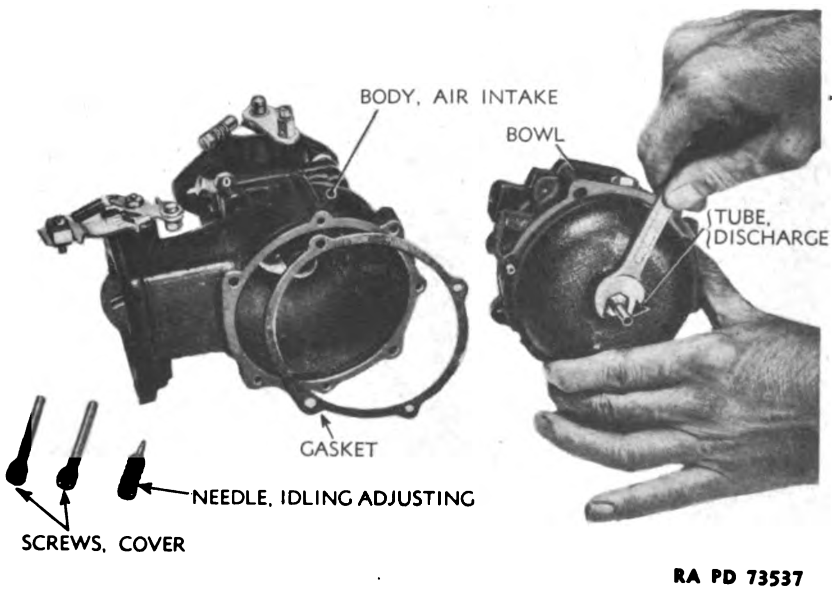


Figure 93 — Discharge Tube Removal

(17) File off the riveted ends of the screws holding throttle plate in shaft. Take out the screws attaching the plate. Slide plate through shaft, and remove. Pull shaft through body, and remove (fig. 100).

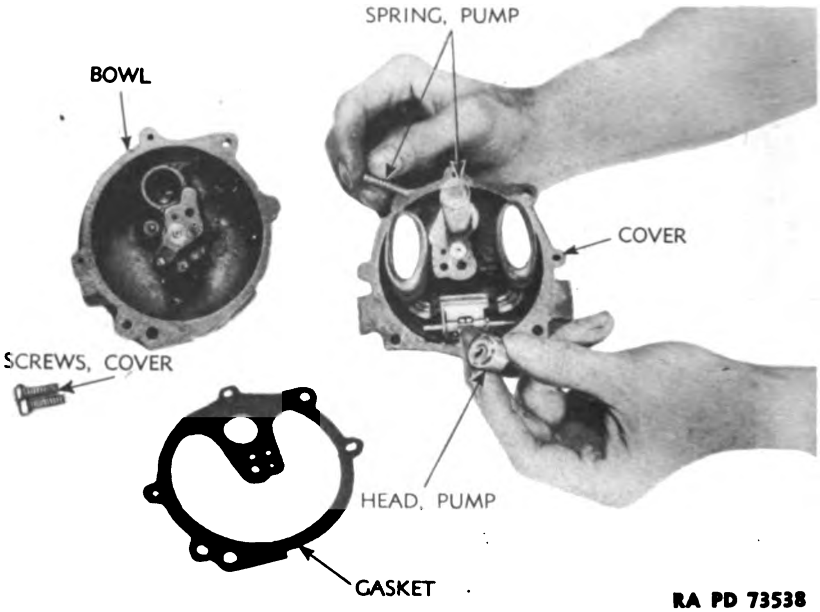


Figure 94 — Pump Assembly Removal

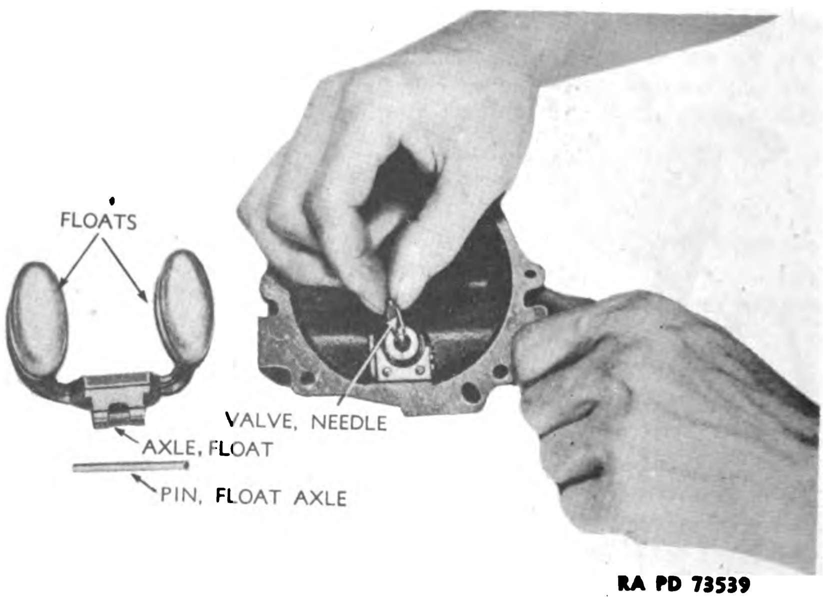


Figure 95 — Fuel Valve Needle Removal

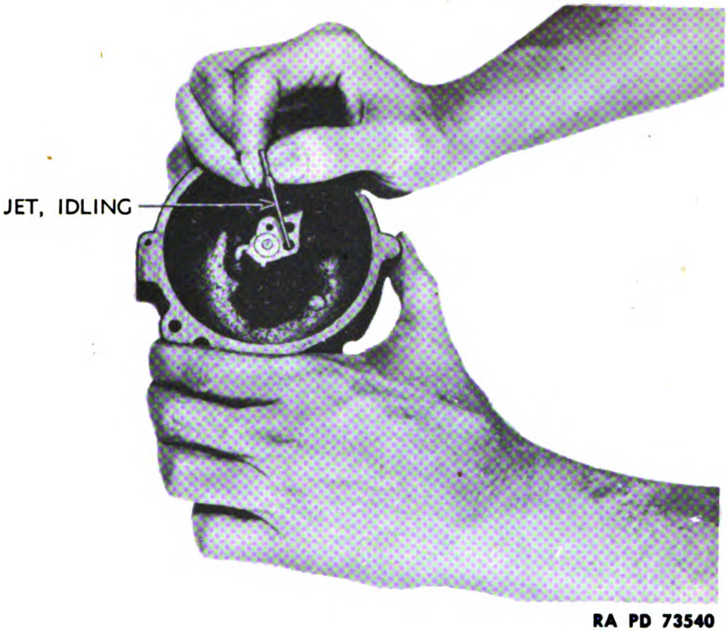


Figure 96 — Idling Jet Removal

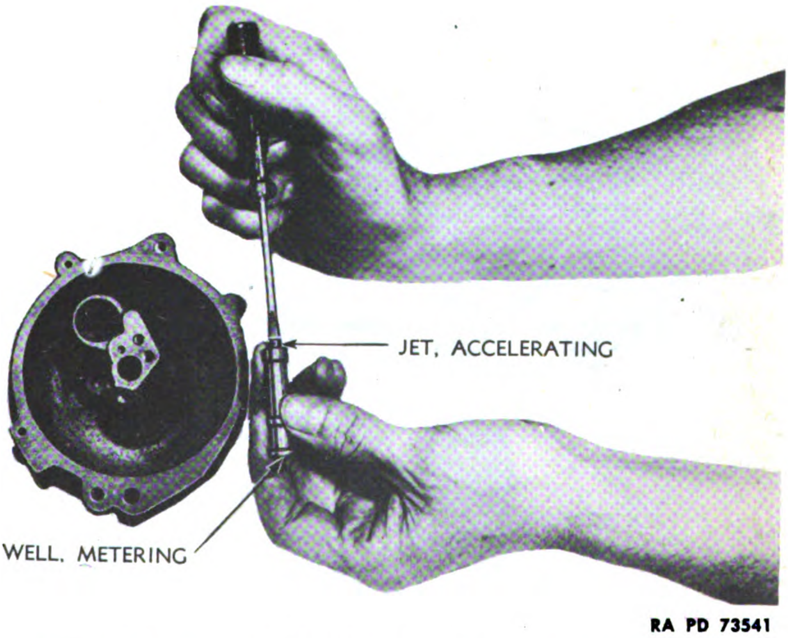


Figure 97 — Removing Accelerating Jet from Metering Well

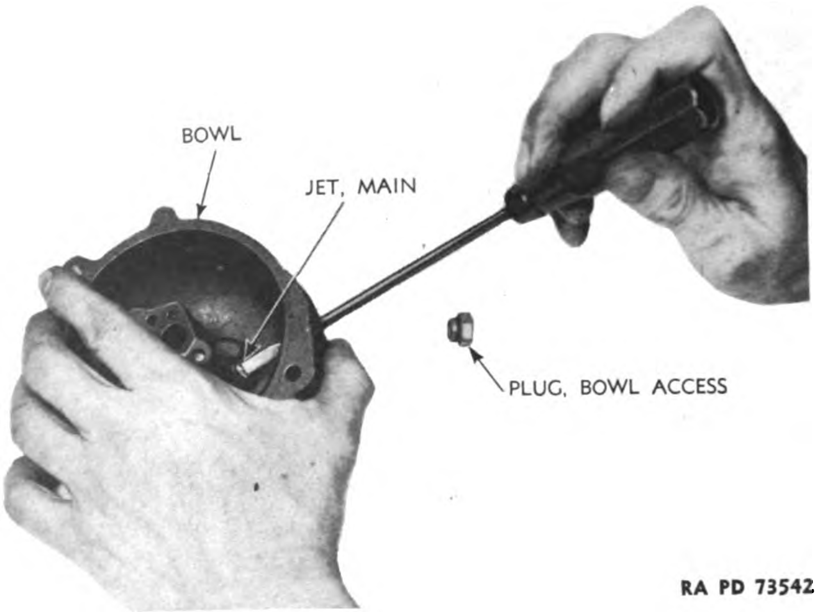


Figure 98 — Main Jet Removal

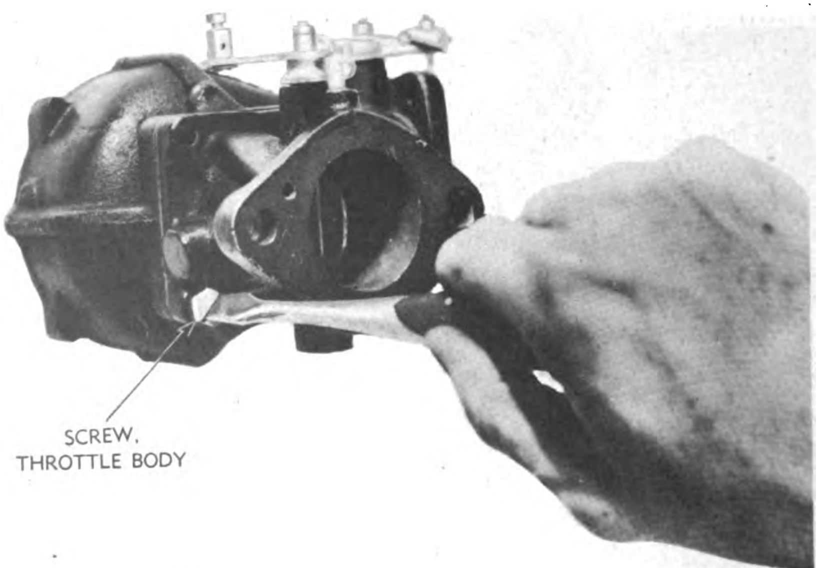


Figure 99 — Throttle Body Removal

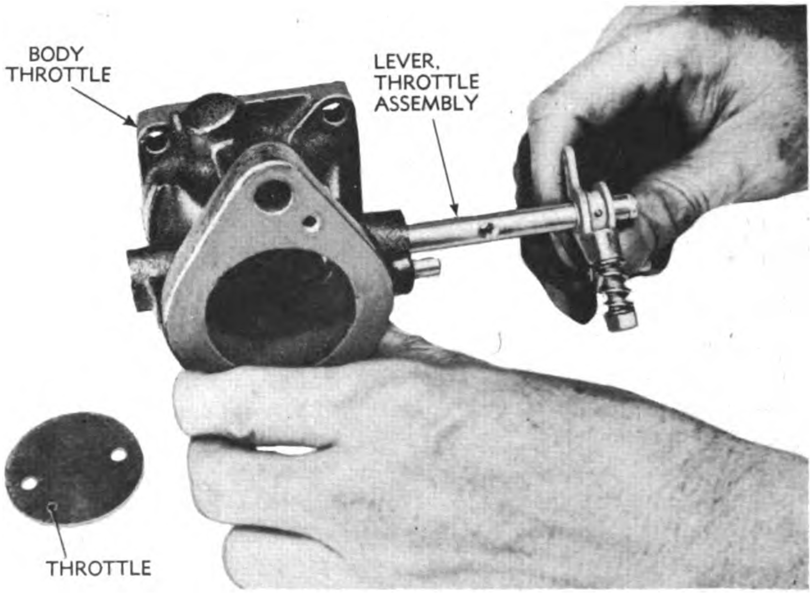


Figure 100 — Throttle Shaft Removal

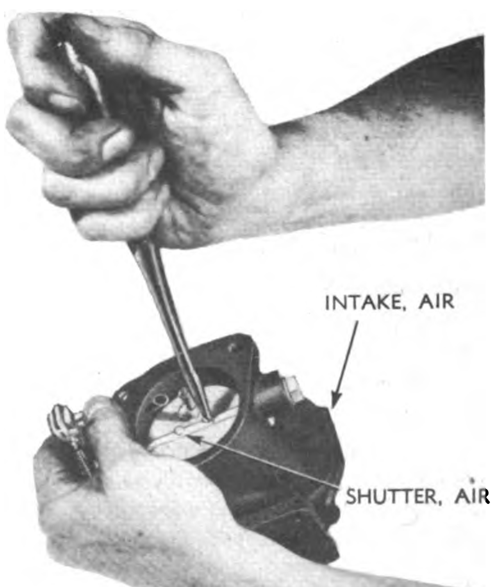


Figure 101 — Removing Air Shutter Retainer Screws

(18) File the riveted ends of the air shutter retainer screws and take out screws (fig. 101). Push air shutter through shaft and remove. Slide shaft out of throttle body with lever in position.

(19) Take out shaft hole plug, and remove plug and gasket.

40. CARBURETOR INSPECTION.

a. Procedure.

(1) A carburetor, in which dirt and other foreign matter have been allowed to accumulate, will seldom function properly. Therefore, wash all parts in SOLVENT, dry-cleaning, and dry with compressed air.

(2) Inspect bowl body, air intake body, and throttle body for cracks and fractures. These are iron castings and may break. Blow out all air and jet holes with compressed air. Be certain air and jet holes are unobstructed.

(3) Inspect condition of solder which holds the halves of each float together. Look for cracks or breaks. Shake floats. If a sloshing sound is heard, indicating gasoline within a float, the float leaks, and must be replaced with a new one.

(4) Examine jets, Venturi tubes, valve seats, and tubes for cracks, fractures, or possible obstructions due to dirt or other foreign matter.

(5) Examine threads of all screws, plugs, nuts, and connections. Be sure drilled openings are free of dirt and foreign matter.

(6) Examine valves, washers, levers, float axle, hinge, and hinge bracket for breakage.

(7) Check all jet orifices with proper size drills. If oversize due to wear, replace with new jets. When replacing jets, make sure new jets have the same calibration numbers as the old.

41. CARBURETOR MAINTENANCE AND REPAIR.

a. Maintenance.

(1) The carburetor should be removed, disassembled, and thoroughly cleaned in SOLVENT, dry-cleaning, at least once a year or every 500 hours of operation.

(2) All carburetor adjustments except idling are fixed, and for this reason the carburetor should not give any trouble, provided regular cleaning and inspection schedules are maintained. However, carburetor jets will wear in service, resulting in an overrich mixture and lack of engine efficiency. Then replacement or overhaul is desirable.

(3) Correct fuel level height is particularly important in obtaining greatest fuel economy. To obtain correct fuel level with normal pump pressure, the distance from the bottom of the float to the bot-

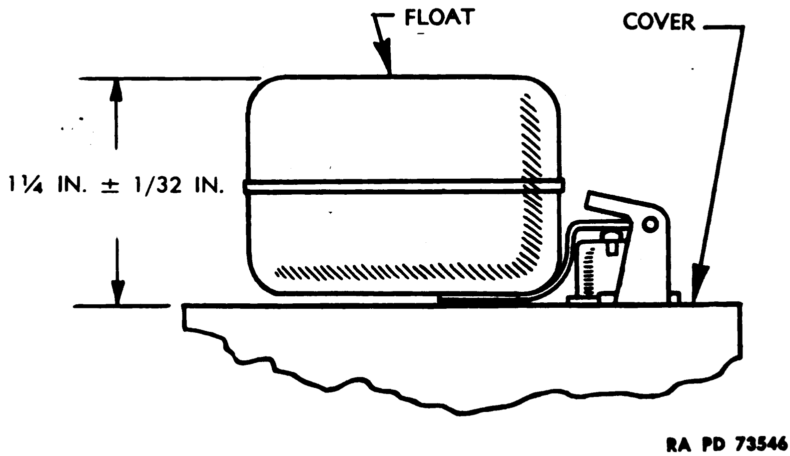


Figure 102 — Float Level Dimension

tom surface of the cover, as shown in figure 102, should be 1¼ inch plus or minus $\frac{1}{32}$ inch. A new and undamaged part will come within these limits.

(4) Uniform idling and part-throttle operation are very much dependent on the location of the priming plug hole in relation to the throttle plate. For this reason, throttle plates and bodies cannot be exchanged indiscriminately. If it is necessary to replace the throttle shaft or plate, back off throttle stop screw so that throttle plate can be completely closed. Holding the throttle in the closed position, scribe a line on the inside of the throttle body along the line of the throttle plate. Using the scribe line as a guide, replace throttle shaft or plate. If new plate shows a noticeable variation from the old one, select another new plate to get one that fits very close to the scribed line when installed.

b. Repair.

(1) Very few of the carburetor components can be repaired. Trouble of any kind except as noted below calls for replacement either of the complete carburetor or of the individual part.

(2) FLOATS. Floats cracked along the seam between the halves can be resoldered.

(3) FUEL LEVEL. To ensure the correct fuel level, with normal pump pressure, the floats should rest so that the distance from the bottom of the floats to the bottom surface of the cover, as shown in figure 102, is 1¼ inch plus or minus $\frac{1}{32}$ inch. If the float arm has been bent, or if for any other reason the floats do not take the proper level the arm may be bent slightly until the floats do take the correct level.

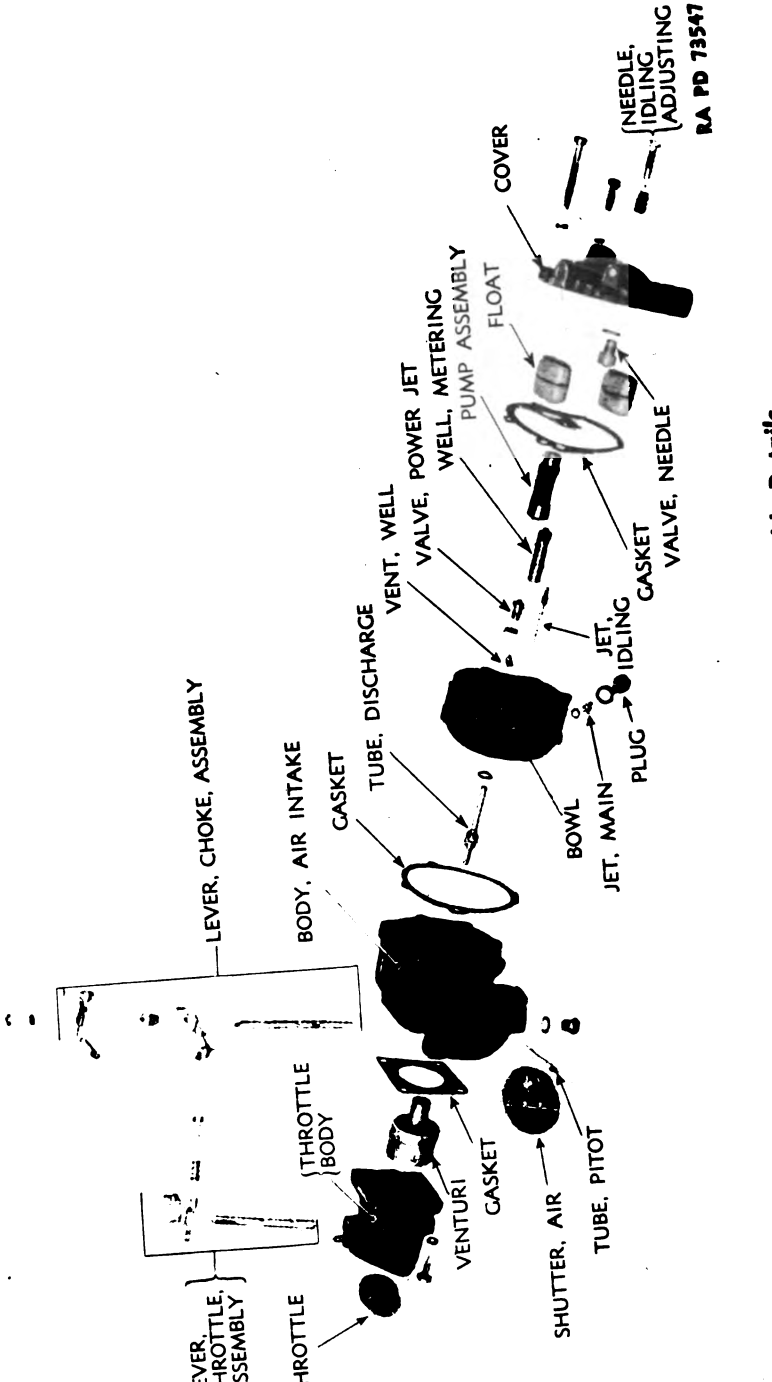


Figure 103 — Carburetor Assembly Details

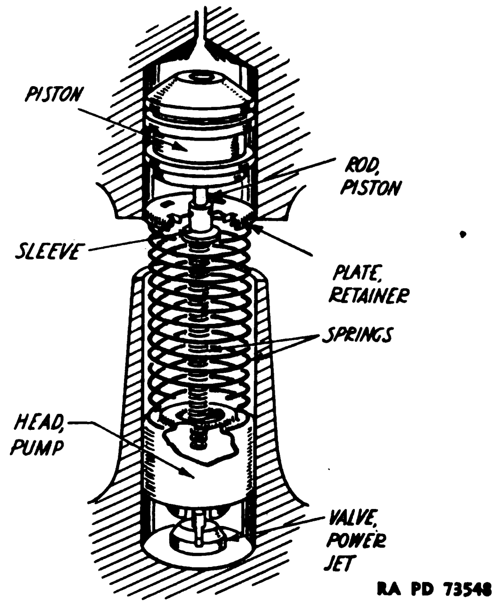


Figure 104 — Carburetor Pump Assembly Diagram

42. CARBURETOR ASSEMBLY (fig. 103).

NOTE: The following special tools are needed:

Tool No. C161-121, Zenith.
Tool No. C161-124, Zenith.

a. Procedure.

(1) Push shaft into throttle body. Insert throttle plate through shaft slot. When throttle plate is properly centered, install new screws to hold it in place. Peen over ends of screws, being careful not to spring the shaft.

(2) Slide air shutter shaft, with arm attached, into place. Insert shutter through shaft slot with relief valve up. Install new holding screws. Peen over ends of screws being careful not to spring the shaft.

(3) Screw hexagonal-head shaft hole plug and gasket into place.

(4) Place the Venturi in the throttle body, install gasket, carefully setting it in proper position so that the locating pin comes in the right place and the body holes are not closed off. Place intake body in position on throttle body, checking passages and locating pin. Turn upside down and install assembly screws. Tighten down evenly and securely.

(5) Install new pump check valve assembly, using tool C161-124

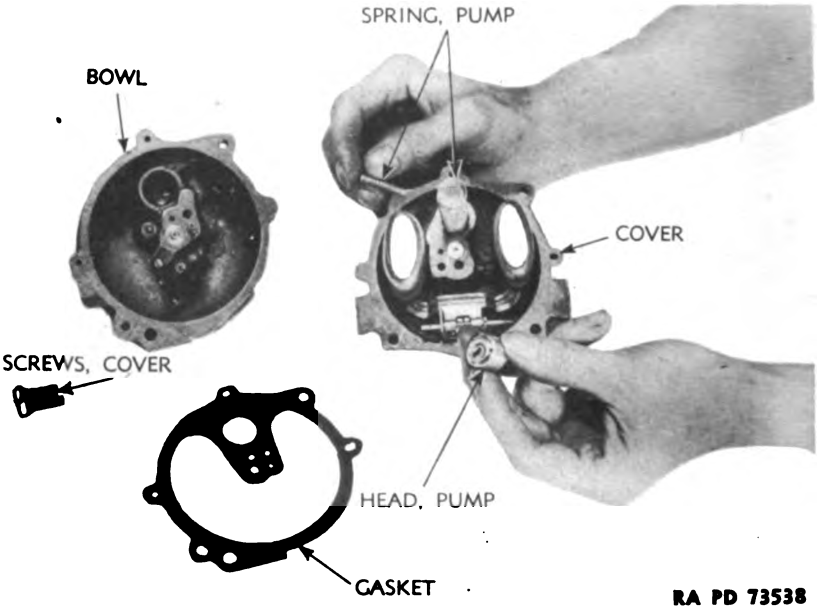


Figure 94 — Pump Assembly Removal

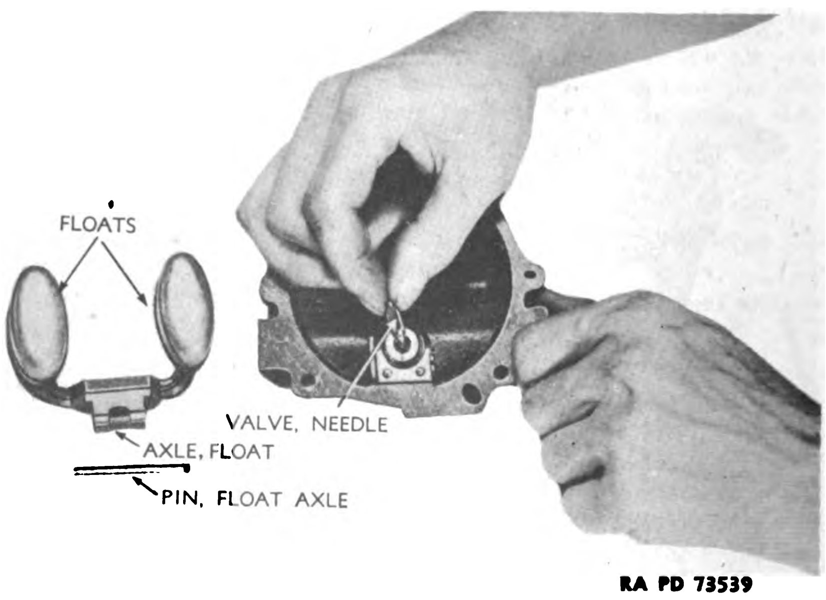


Figure 95 — Fuel Valve Needle Removal

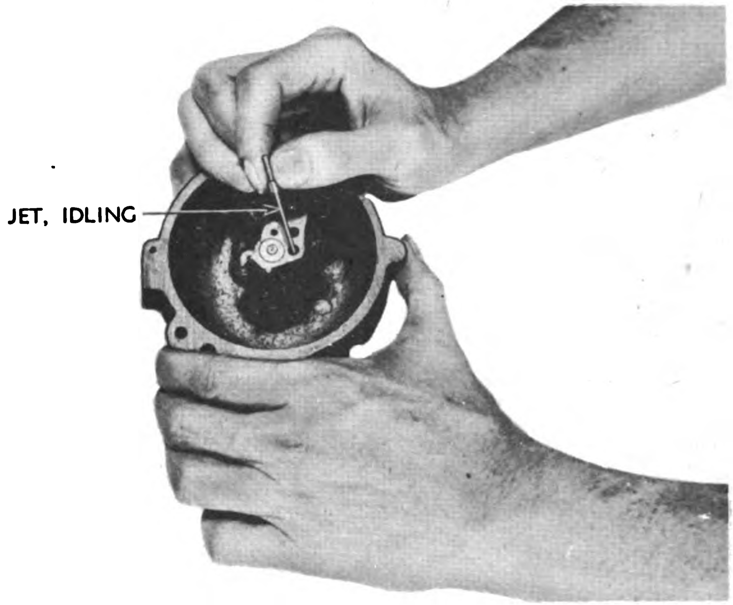


Figure 96 — Idling Jet Removal

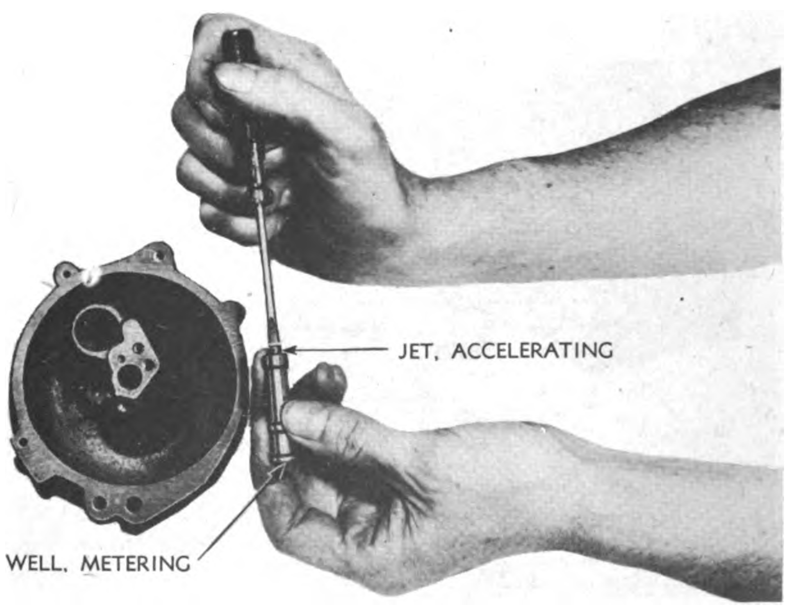


Figure 97 — Removing Accelerating Jet from Metering Well

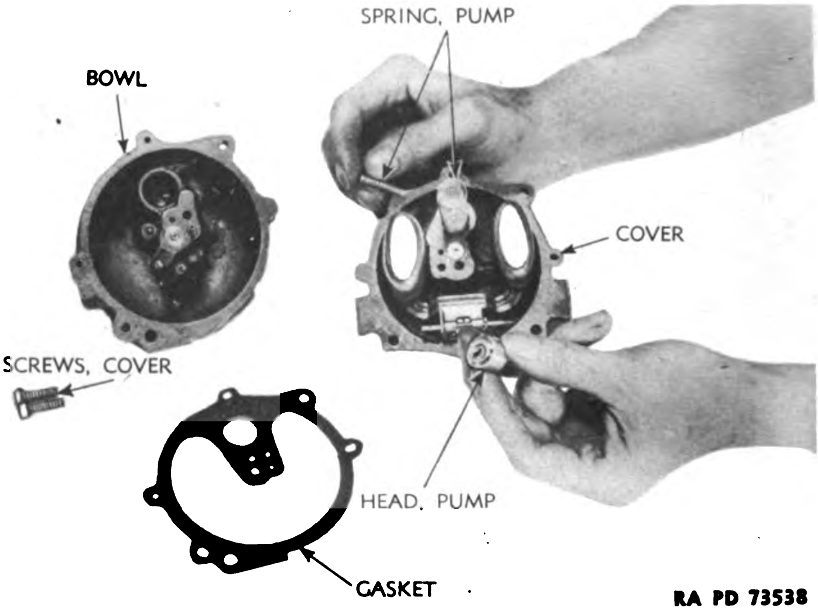
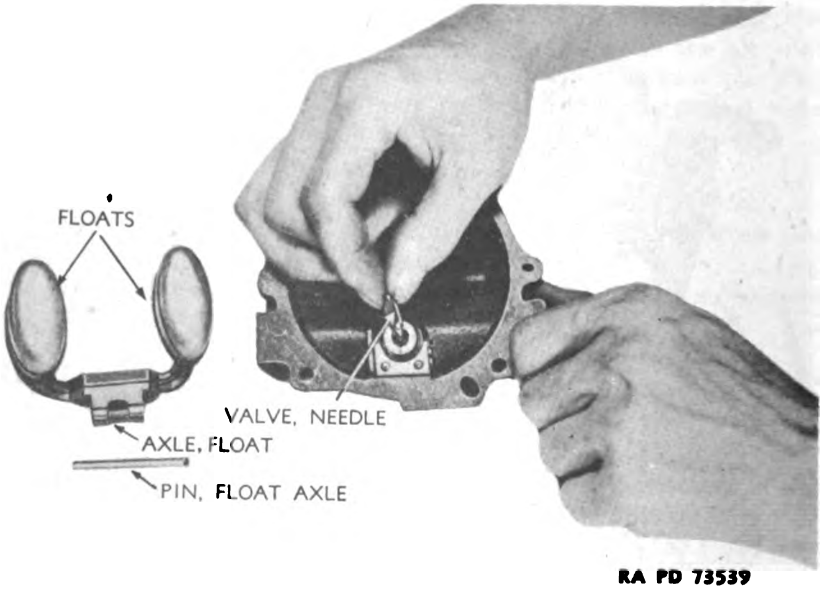


Figure 94 — Pump Assembly Removal



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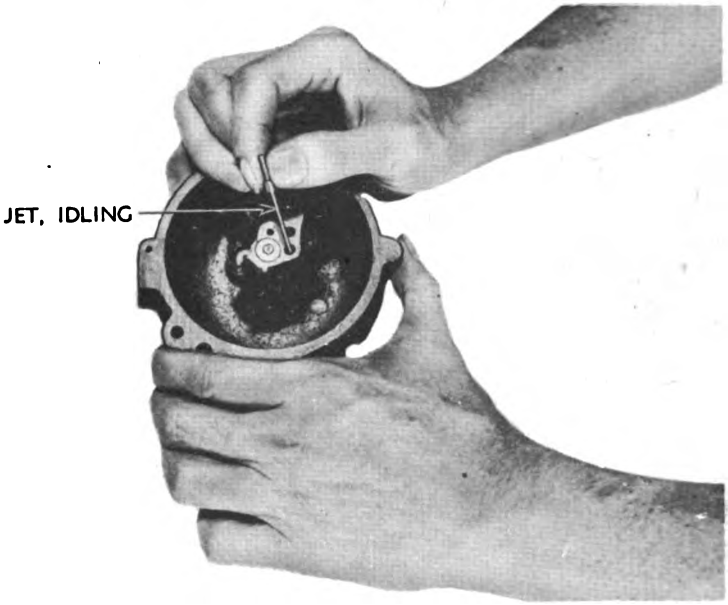

Figure 96 — Idling Jet Removal

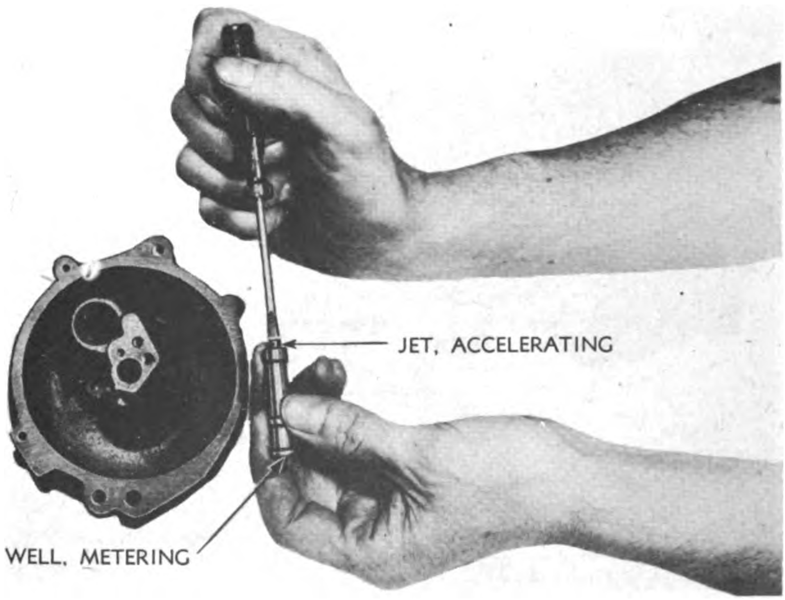

Figure 97 — Removing Accelerating Jet from Metering Well

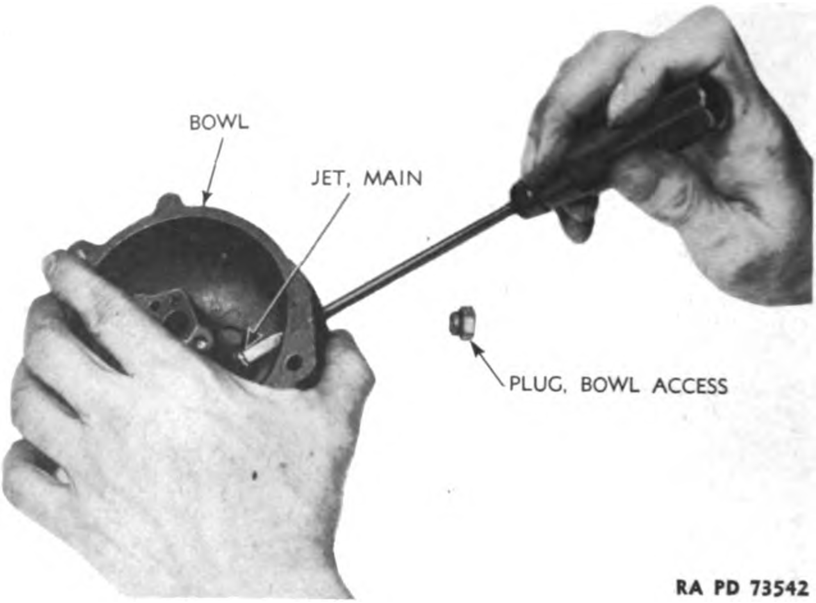

Figure 98 — Main Jet Removal

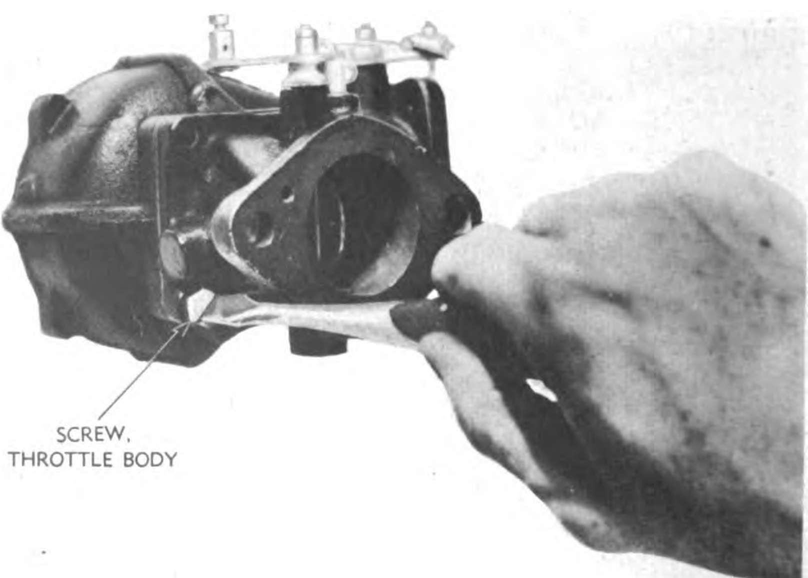

Figure 99 — Throttle Body Removal

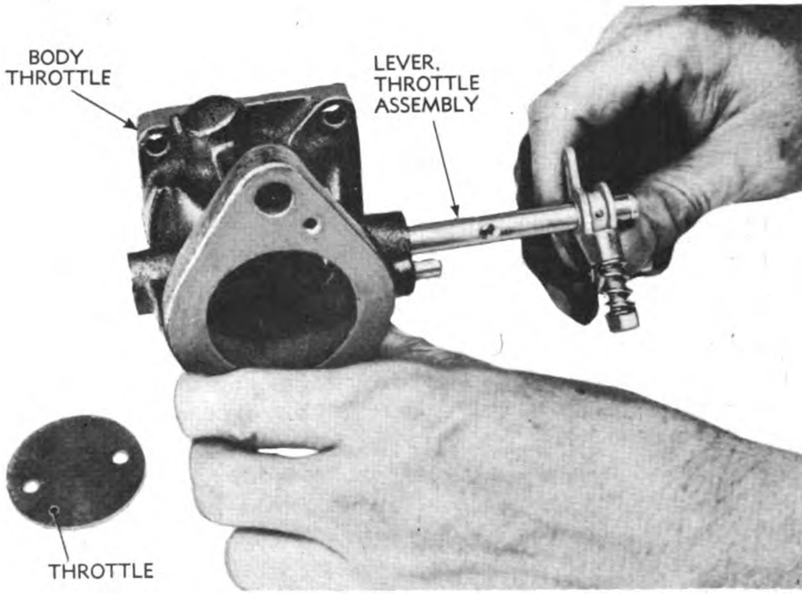

Figure 100 — Throttle Shaft Removal

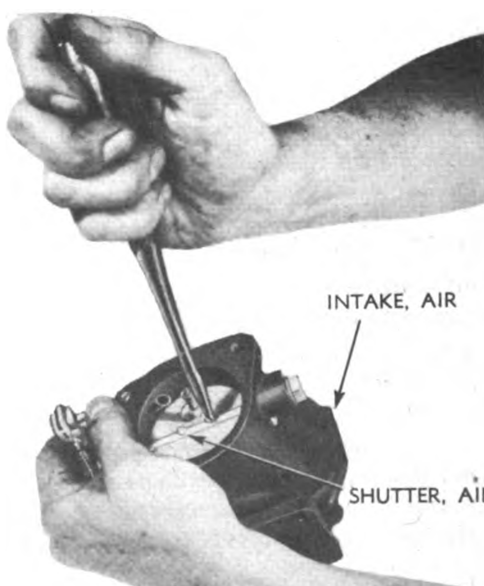

Figure 101 — Removing Air Shutter Retainer Screws

(18) File the riveted ends of the air shutter retainer screws and take out screws (fig. 101). Push air shutter through shaft and remove. Slide shaft out of throttle body with lever in position.

(19) Take out shaft hole plug, and remove plug and gasket.

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(3) Inspect condition of solder which holds the halves of each float together. Look for cracks or breaks. Shake floats. If a sloshing sound is heard, indicating gasoline within a float, the float leaks, and must be replaced with a new one.

(4) Examine jets, Venturi tubes, valve seats, and tubes for cracks, fractures, or possible obstructions due to dirt or other foreign matter.

(5) Examine threads of all screws, plugs, nuts, and connections. Be sure drilled openings are free of dirt and foreign matter.

(6) Examine valves, washers, levers, float axle, hinge, and hinge bracket for breakage.

(7) Check all jet orifices with proper size drills. If oversize due to wear, replace with new jets. When replacing jets, make sure new jets have the same calibration numbers as the old.

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(2) All carburetor adjustments except idling are fixed, and for this reason the carburetor should not give any trouble, provided regular cleaning and inspection schedules are maintained. However, carburetor jets will wear in service, resulting in an overrich mixture and lack of engine efficiency. Then replacement or overhaul is desirable.

(3) Correct fuel level height is particularly important in obtaining greatest fuel economy. To obtain correct fuel level with normal pump pressure, the distance from the bottom of the float to the bot-

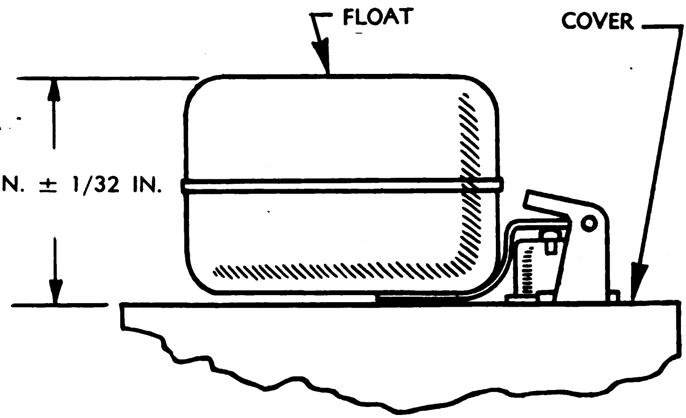

Figure 102 — Float Level Dimension

tom surface of the cover, as shown in figure 102, should be 1¼ inch plus or minus $\frac{1}{32}$ inch. A new and undamaged part will come within these limits.

(4) Uniform idling and part-throttle operation are very much dependent on the location of the priming plug hole in relation to the throttle plate. For this reason, throttle plates and bodies cannot be exchanged indiscriminately. If it is necessary to replace the throttle shaft or plate, back off throttle stop screw so that throttle plate can be completely closed. Holding the throttle in the closed position, scribe a line on the inside of the throttle body along the line of the throttle plate. Using the scribe line as a guide, replace throttle shaft or plate. If new plate shows a noticeable variation from the old one, select another new plate to get one that fits very close to the scribed line when installed.

b. Repair.

(1) Very few of the carburetor components can be repaired. Trouble of any kind except as noted below calls for replacement either of the complete carburetor or of the individual part.

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(3) FUEL LEVEL. To ensure the correct fuel level, with normal pump pressure, the floats should rest so that the distance from the bottom of the floats to the bottom surface of the cover, as shown in figure 102, is 1¼ inch plus or minus $\frac{1}{32}$ inch. If the float arm has been bent, or if for any other reason the floats do not take the proper level the arm may be bent slightly until the floats do take the correct level.

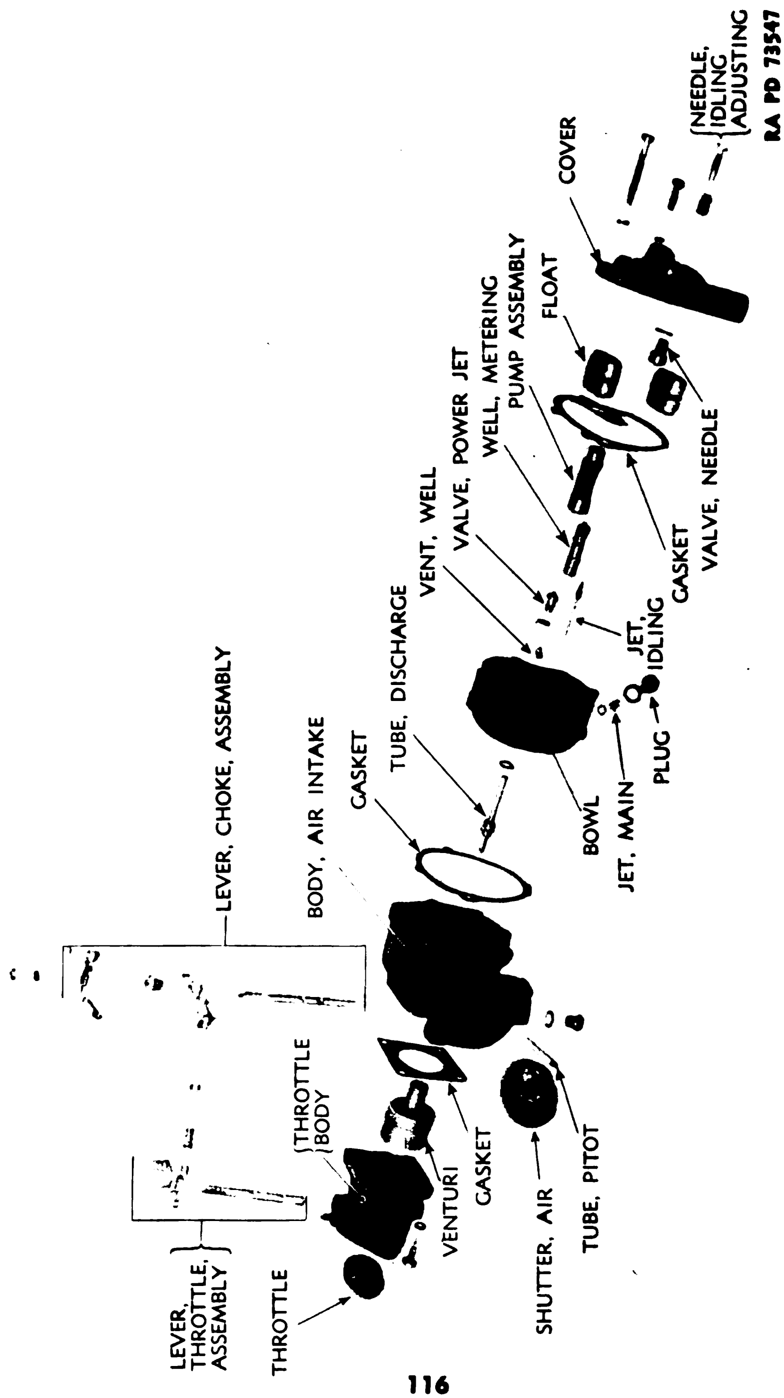


Figure 103 — Carburetor Assembly Details

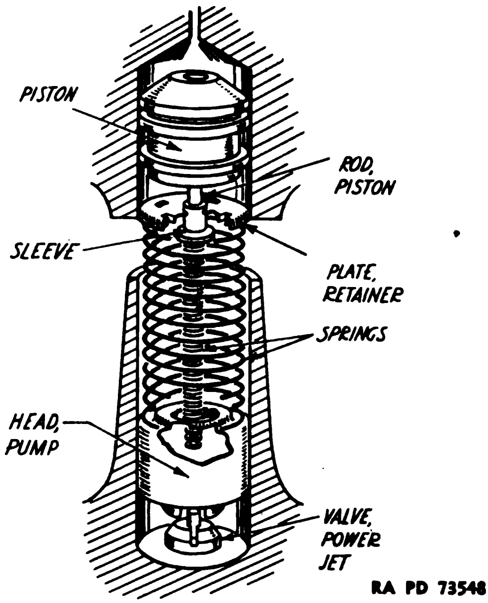


Figure 104 — Carburetor Pump Assembly Diagram

42. CARBURETOR ASSEMBLY (fig. 103).

NOTE: The following special tools are needed:

Tool No. C161-121, Zenith.

Tool No. C161-124, Zenith.

a. Procedure.

(1) Push shaft into throttle body. Insert throttle plate through shaft slot. When throttle plate is properly centered, install new screws to hold it in place. Peen over ends of screws, being careful not to spring the shaft.

(2) Slide air shutter shaft, with arm attached, into place. Insert shutter through shaft slot with relief valve up. Install new holding screws. Peen over ends of screws being careful not to spring the shaft.

(3) Screw hexagonal-head shaft hole plug and gasket into place.

(4) Place the Venturi in the throttle body, install gasket, carefully setting it in proper position so that the locating pin comes in the right place and the body holes are not closed off. Place intake body in position on throttle body, checking passages and locating pin. Turn upside down and install assembly screws. Tighten down evenly and securely.

(5) Install new pump check valve assembly, using tool C161-124

to hold the new valve in place, while using a hammer to drive the valve in.

(6) Install main jet, with new gasket, through bowl plug hole. Install bowl plug and new gasket.

(7) Install power jet valve and new gasket. Have tool No. C161-121 properly centered on the valve head.

(8) Install accelerating jet in the metering well using a small screwdriver while holding the metering well with the hand only. Install metering well and accelerating jet in the well channel. The metering well is designed to extend not more than 0.015 inch above the bowl casting to insure a good fit at that point when gasket and cover are in place.

(9) Screw well vent down in place.

(10) Set idling jet in place.

(11) To install pump refill check valve, place the valve body, head down, on a flat metal block; place the valve disk in the valve body; place the cover casting squarely over the valve, then strike the casting with a hammer to drive the cover down over the valve. Valve ends should be just flush with the casting.

(12) Screw fuel valve seat and new gasket into place. Insert needle.

(13) Place the float bracket in position in float hinge bracket and secure with wire pin float axle. The float should move freely on the axle. Hold the float level upside down as shown in figure 102 to observe relation of float to cover.

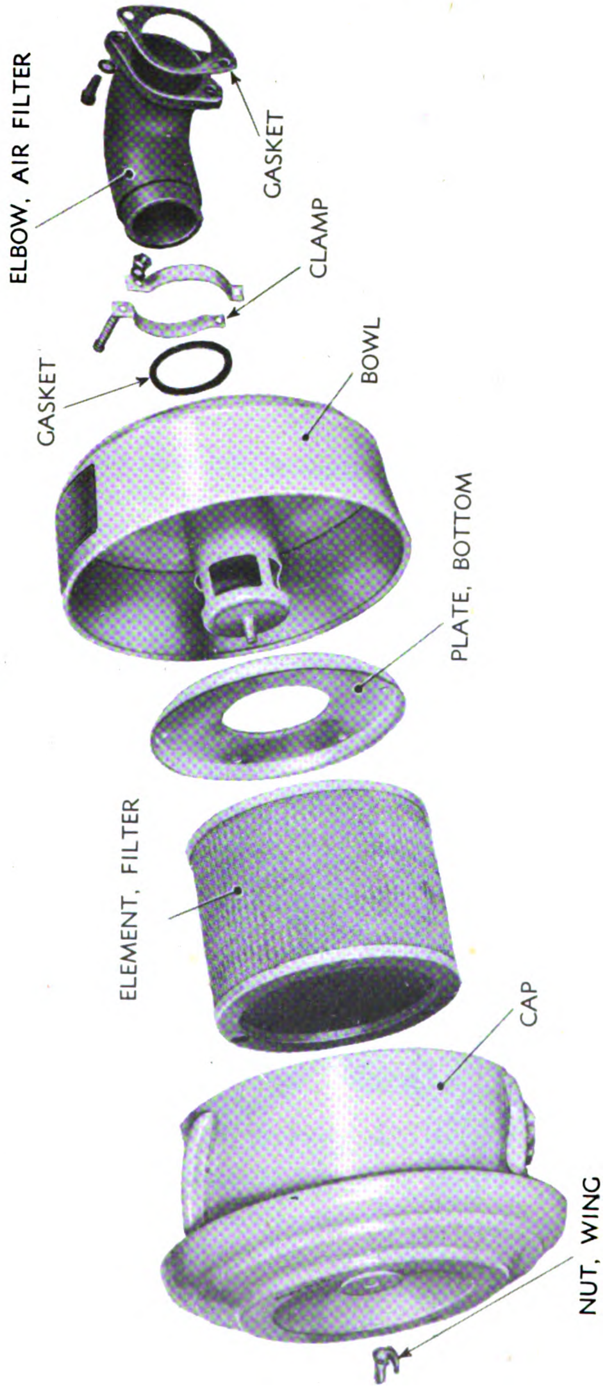
(14) Place piston rod and piston head in chamber. Secure in place with retainer plate. Slide sleeve and small spring over piston rod. Insert large spring into retainer plate flange. Attach brass pump head (fig. 104).

(15) Place the bowl to cover gasket in position on the bowl. Hold the cover assembly over the bowl, and guide the vacuum piston into the vacuum cylinder and the idling jet into its channel, being careful to avoid damage to float and other parts. Install cover to bowl assembly screws and lock washers. Tighten them evenly and securely.

(16) Screw discharge tube and new gasket into place in lower side of bowl.

(17) Place bowl to intake gasket in position on the bowl. Place the bowl assembly with gasket on the air intake. Be sure the channel bushings enter their respective channels. Install the assembly screws, and tighten evenly and securely.

(18) Place spring over idling adjusting screw, and install in tapped hole in cover.



RA PD 73549

Figure 105 — Air Filter and Elbow Assembly

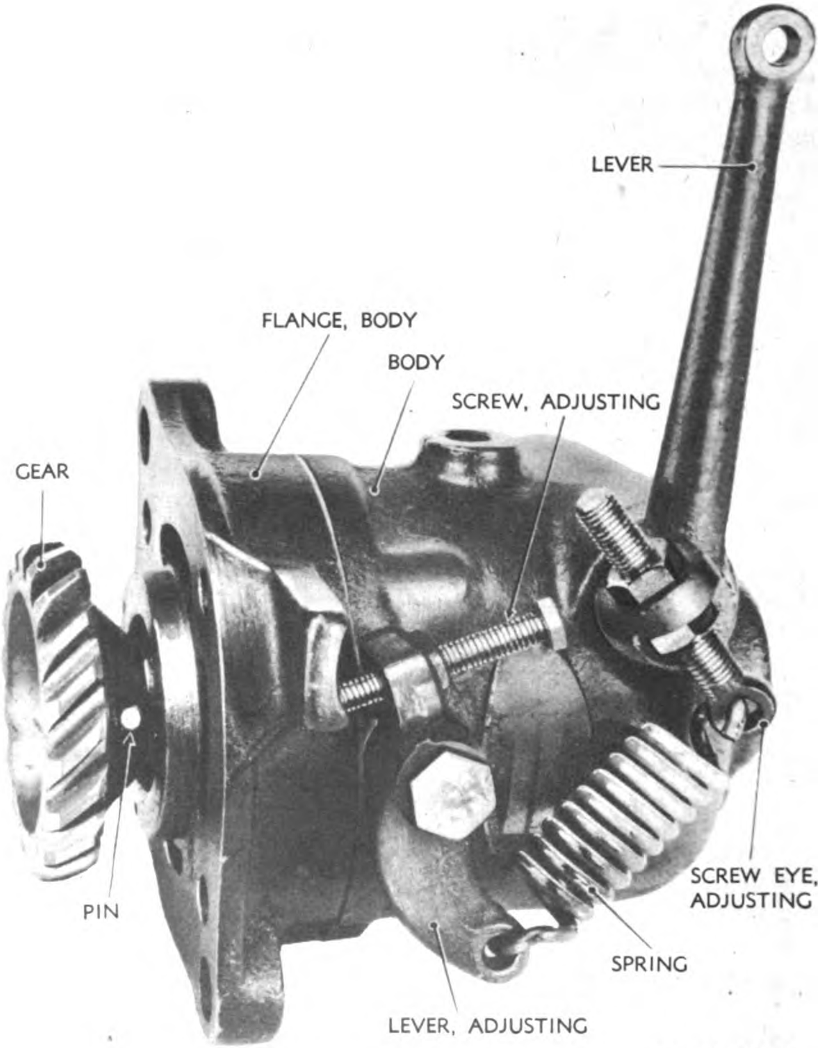


Figure 106 — Governor

43. AIR FILTER (fig. 105).

a. **Removal.** Loosen clamp bolts holding filter bowl flange to air filter elbow and remove clamp, gasket, and filter.

b. **Disassembly.** Unscrew the wing nut at the top of the cap and remove, in sequence, cap, filter element, and baffle plate.

c. **Inspection and Repair.**

(1) Examine element to see if it is bent. Solder screen to sheet metal if loose.

(2) Straighten baffle plate, cap, and bowl, if they are bent.

(3) Pour water into bowl to test for leakage. Solder any leaks.

d. **Assembly.**

(1) Slip baffle plate into position in the bowl.

(2) Fill bowl to bead level with used crankcase oil or OIL, engine, (crankcase grade).

(3) Set element in place on baffle plate.

(4) Bring cap down over element and clamp the assembly together, screwing the wing nut onto the bowl stud.

e. **Installation.** Set filter down on the flange of the air filter elbow. Set the collar clamp and gasket in place, and secure the filter to the elbow by tightening the clamp bolts.

f. **Servicing Air Filter.**

(1) DAILY INSPECTION.

(a) Check tightness of clamp bolts.

(b) Under extremely dusty conditions, change oil in bowl daily.

(2) 150-HOUR SERVICING.

(a) Remove filter, disassemble, and empty oil from bowl.

(b) Clean element by swishing about in SOLVENT, dry-cleaning. Clean bowl, fill with used crankcase oil or OIL, engine, (crankcase grade).

44. GOVERNOR AND THROTTLE BOX DESCRIPTION.

a. The governor (fig. 106) is of the centrifugal "flyball" type. The governor spring force tends to hold the throttle valve in a wide-open position, and the weight force, opposing the spring, tends to close the valve.

b. The governor spring is located outside the governor case, with one end hooked to the speed adjusting lever and the other end an-

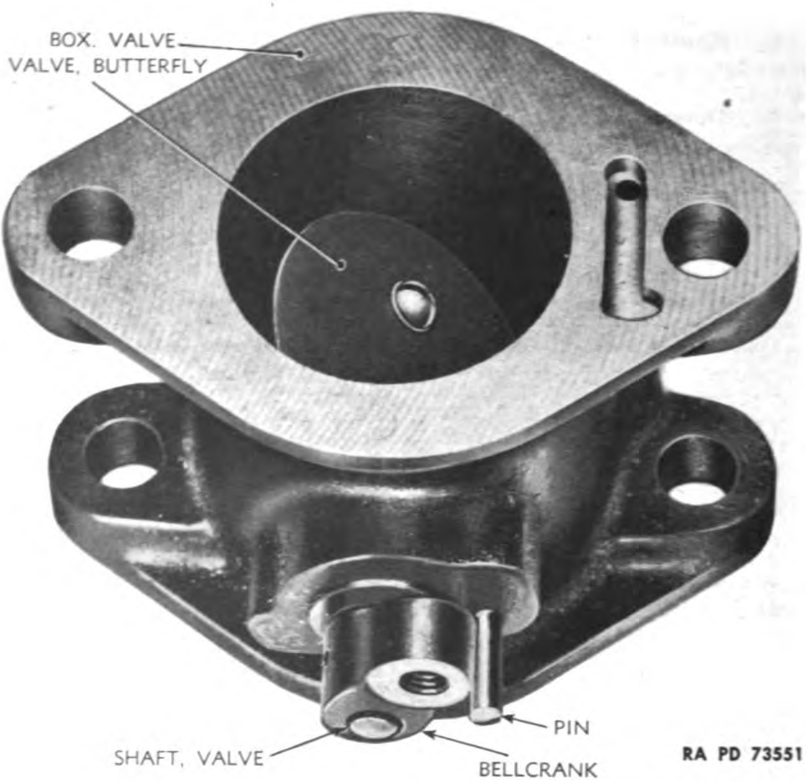


Figure 107 — Throttle Box

chored to the auxiliary adjusting screw eye on the rocker shaft. Increasing tension on the governor spring increases engine speed. Inside of the governor, the weights are hung on a weight spider fastened to the rotating drive shaft. As the weights revolve, centrifugal force tends to throw the mass of the weights outward. The weights pivot on the weight pins, converting the centrifugal force to a thrust against the thrust sleeve which moves longitudinally on the drive shaft.

c. Movement of the thrust sleeve is transmitted to the rocker shaft by means of the yoke, which contacts the thrust bearing pressed on the thrust sleeve.

d. When the engine is not running, the governor spring holds the throttle valve wide open. When the engine is started, the weights swing out and move the throttle valve towards the closed position. The weights continue to move out until the weight force and the opposing spring force are in balance. With the weight and spring forces

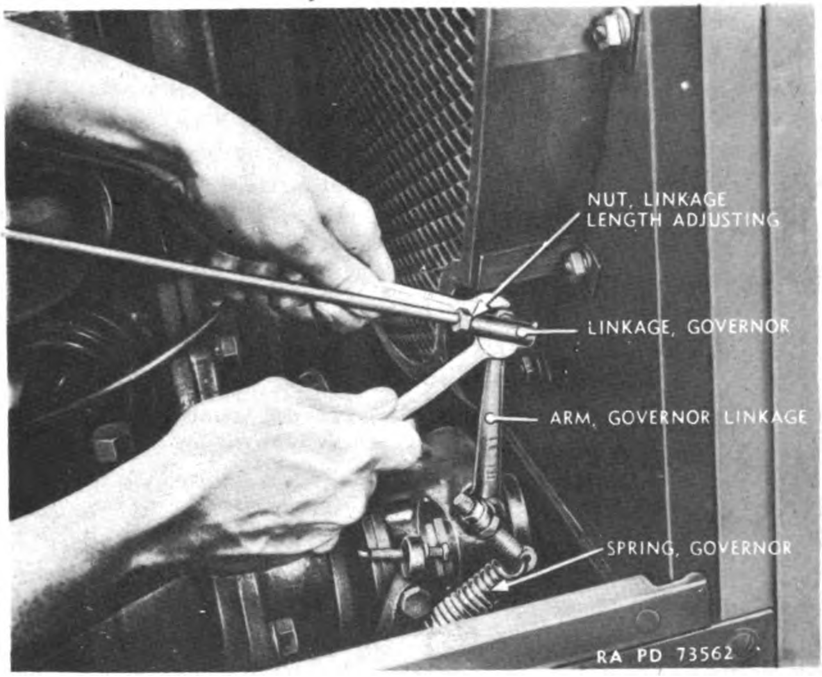


Figure 108 — Disconnecting Governor Linkage at Governor

in balance, the throttle will be set to maintain the predetermined governed speed.

e. If load is applied, the engine slows down and the spring force will open the throttle. If the load is thrown off, engine speed increases, and the increased weight force closes the throttle to maintain the governed revolutions per minute.

f. The throttle box (fig. 107) is of the conventional butterfly type, with the valve shaft mounted on ball bearings.

g. The connecting rod assembly uses "screw set" ball joints to overcome angularity and to eliminate friction.

45. GOVERNOR REMOVAL.

a. Procedure.

(1) Hold nut and take out screw fastening governor linkage to governor arm. *Do not disconnect at throttle box* (fig. 108).

(2) Remove nut holding oil line in compression fitting at the top of governor (fig. 21).

(3) Take out cap screws holding governor to housing (fig. 22), and remove governor.

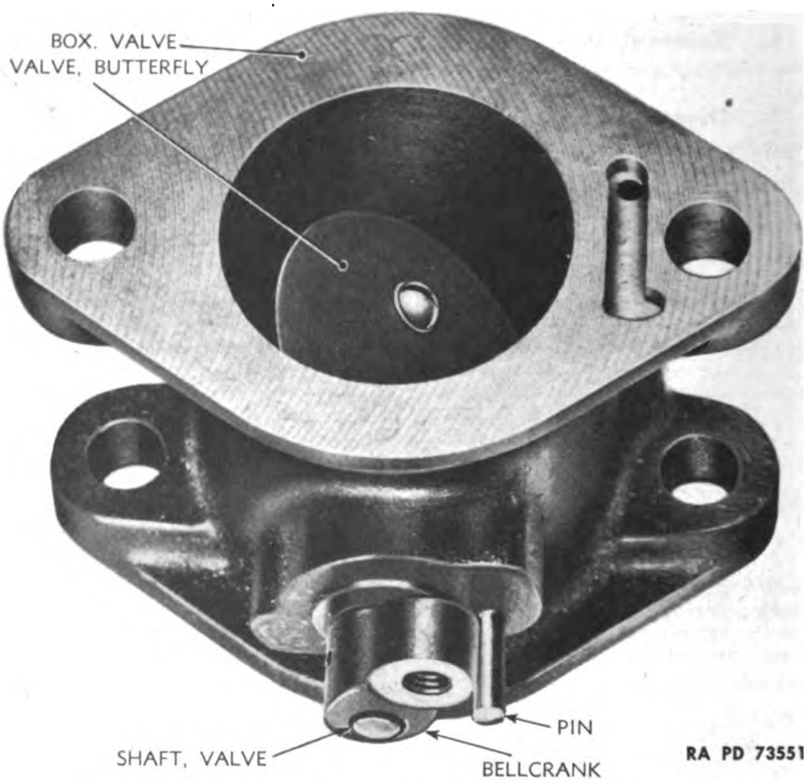


Figure 107 — Throttle Box

chored to the auxiliary adjusting screw eye on the rocker shaft. Increasing tension on the governor spring increases engine speed. Inside of the governor, the weights are hung on a weight spider fastened to the rotating drive shaft. As the weights revolve, centrifugal force tends to throw the mass of the weights outward. The weights pivot on the weight pins, converting the centrifugal force to a thrust against the thrust sleeve which moves longitudinally on the drive shaft.

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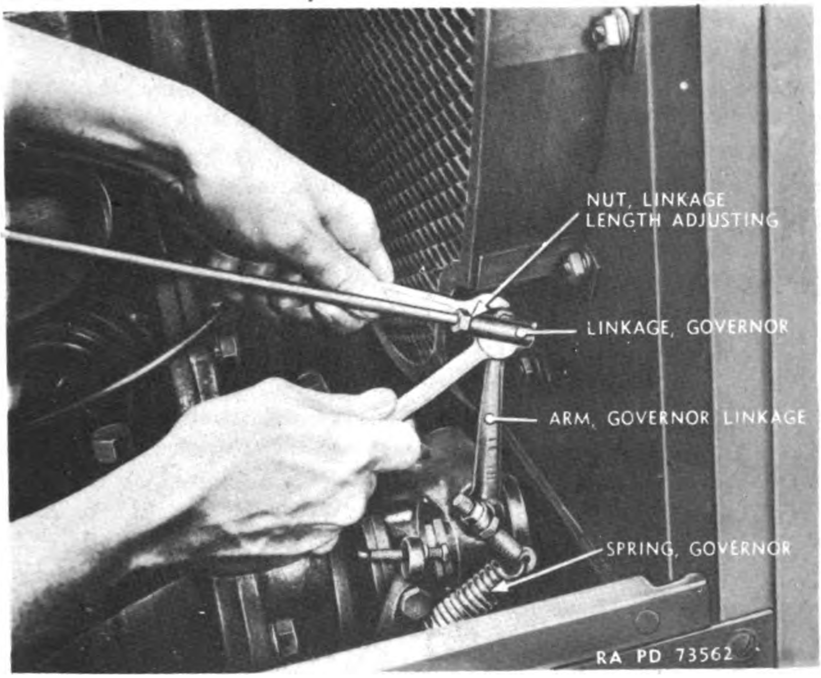

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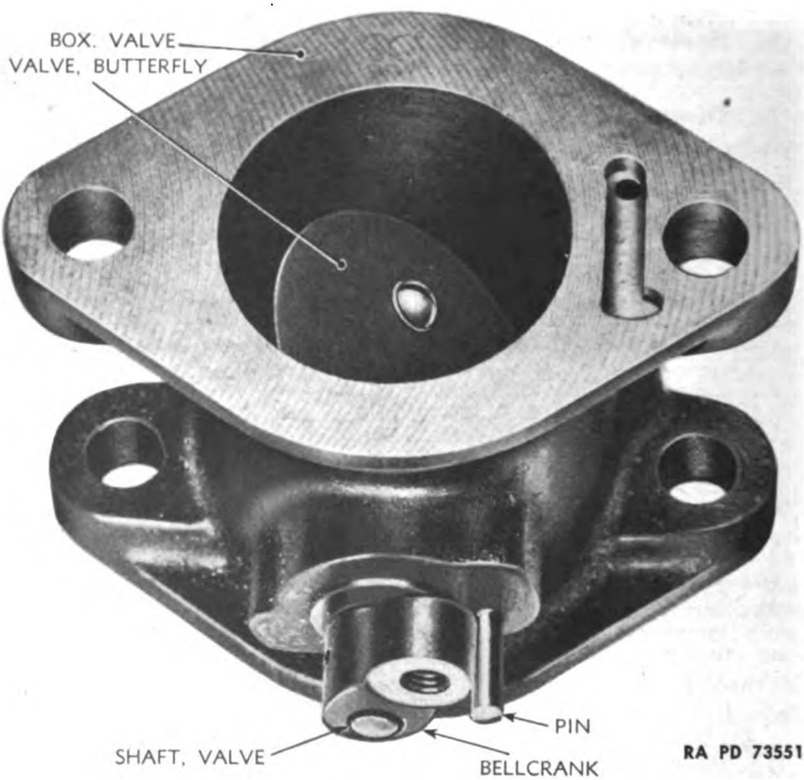

Figure 107 — Throttle Box

chored to the auxiliary adjusting screw eye on the rocker shaft. Increasing tension on the governor spring increases engine speed. Inside of the governor, the weights are hung on a weight spider fastened to the rotating drive shaft. As the weights revolve, centrifugal force tends to throw the mass of the weights outward. The weights pivot on the weight pins, converting the centrifugal force to a thrust against the thrust sleeve which moves longitudinally on the drive shaft.

c. Movement of the thrust sleeve is transmitted to the rocker shaft by means of the yoke, which contacts the thrust bearing pressed on the thrust sleeve.

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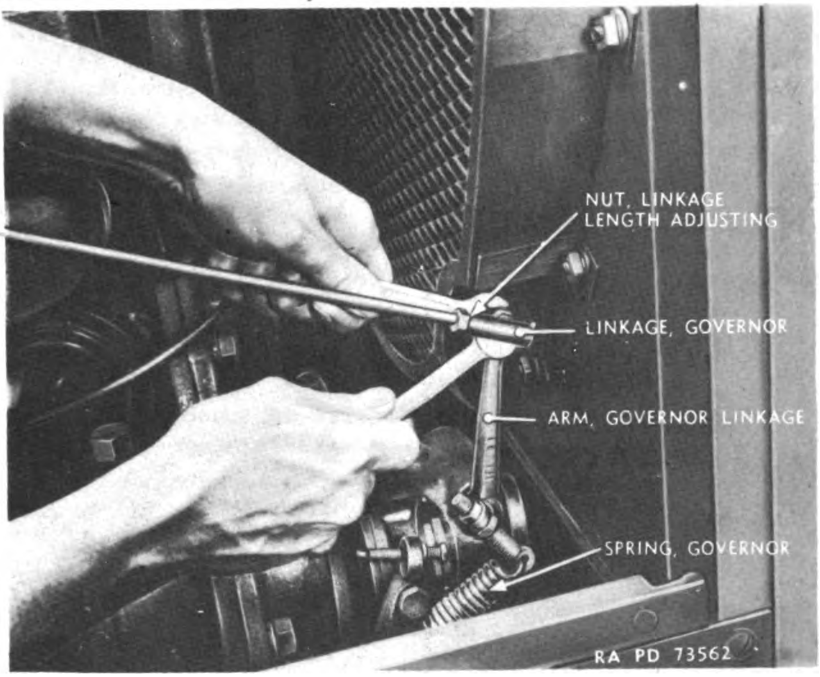

Figure 108 — Disconnecting Governor Linkage at Governor

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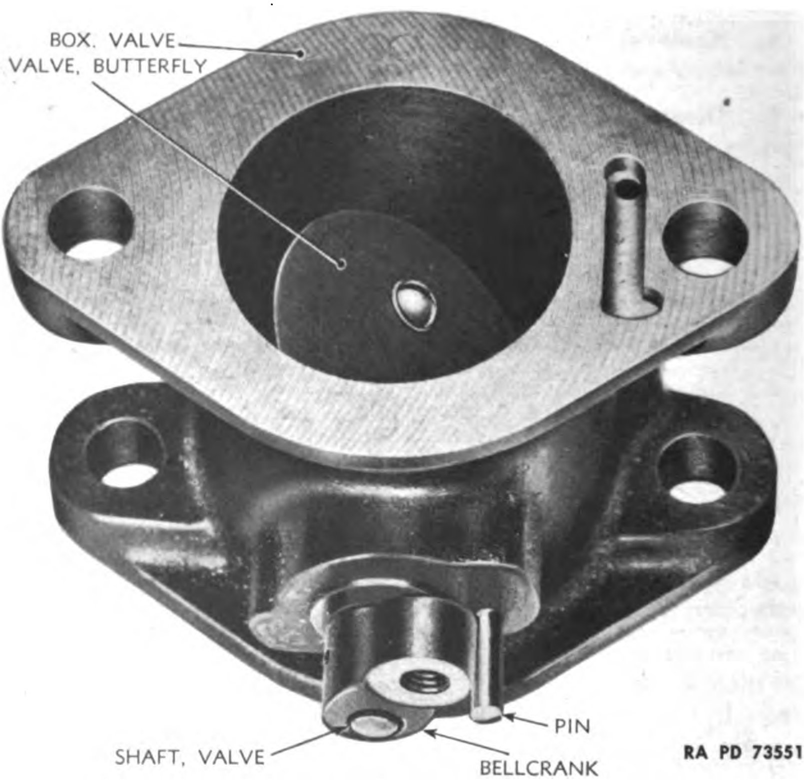

Figure 107 — Throttle Box

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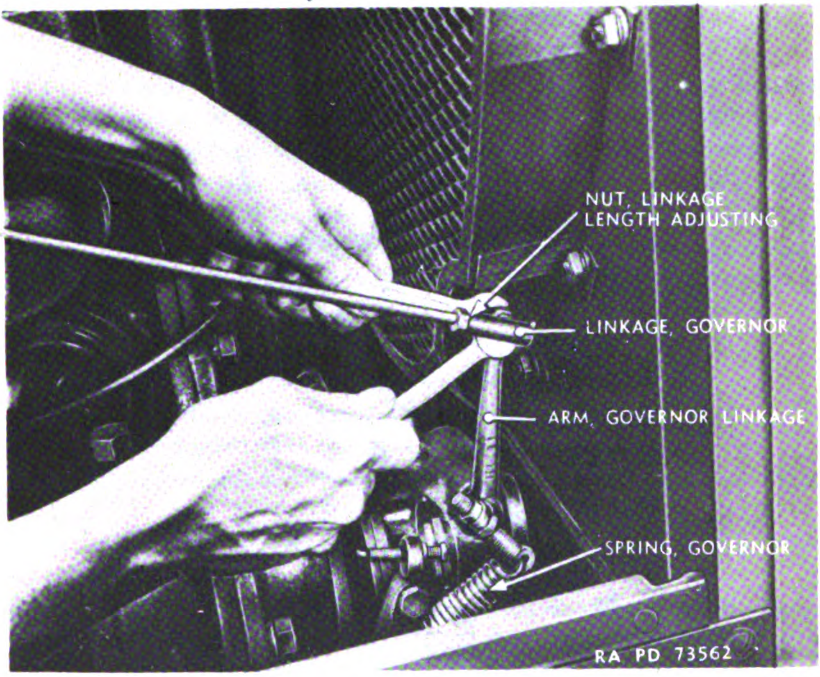

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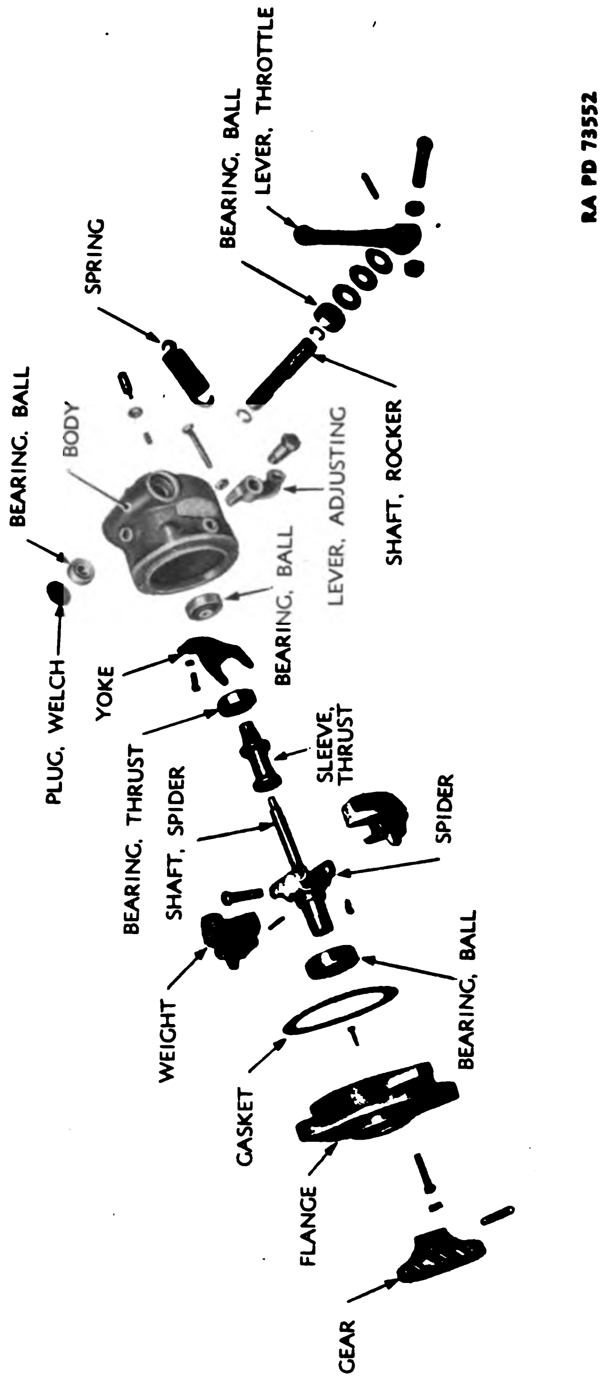

Figure 109 — Governor — Exploded View

46. GOVERNOR DISASSEMBLY (fig. 109).

a. Procedure.

(1) Release tension from governor spring by loosening holding cap screw and lock nut. Remove shoulder screw, and remove spring.

(2) Remove the four screws holding body to flange, and separate.

(3) Take out the three round-head screws and washers inside the flange holding the bearing retainer to the flange.

(4) Punch groove pin out through gear and shaft. Press gear from shaft (fig. 110). The bearing will be forced out of the casting seat in this operation.

(5) Press bearing and sleeve from shaft (fig. 111).

(6) Slide thrust sleeve and bearing off shaft.

(7) Grind down the peened-over ends of the pins holding the weights to the spider, take out pins, and remove weights.

(8) Drive groove pin through spider and shaft. Press spider from shaft.

(9) Take out cap screws and lock washers, and remove yoke from rocker shaft.

(10) Drive out taper pin holding lever to rocker shaft. Drive rocker shaft through lever, knocking out end bearing and welch plug (fig. 112). Reverse shaft, and use it for a punch to knock out the remaining bearing.

47. GOVERNOR INSPECTION AND REPAIR.

a. Individual parts of disassembled governor should be carefully washed in SOLVENT, dry-cleaning, before making the following inspections.

(1) GASKET, FASTENING SCREWS, NUTS, AND WASHERS. These should be replaced if damaged.

(2) GEAR. Inspect for wear or broken teeth, and replace if necessary.

(3) BEARING AND SLEEVES. These should be inspected for excessive wear, and replaced if necessary.

(4) SPRING. Check for rust spots or signs of corrosion. Replace, if corroded or if bent or broken.

(5) WEIGHTS AND SPIDER. Weights should move freely on pivot pins, but they should not be too loose. Spider should not hug the weights, but should permit easy play. If spider is bent or damaged, it should be replaced.

(6) SPIDER SHAFT. Inspect for wear or damage, and replace if necessary.

(7) YOKE. Check for wear or damage, and replace if necessary.

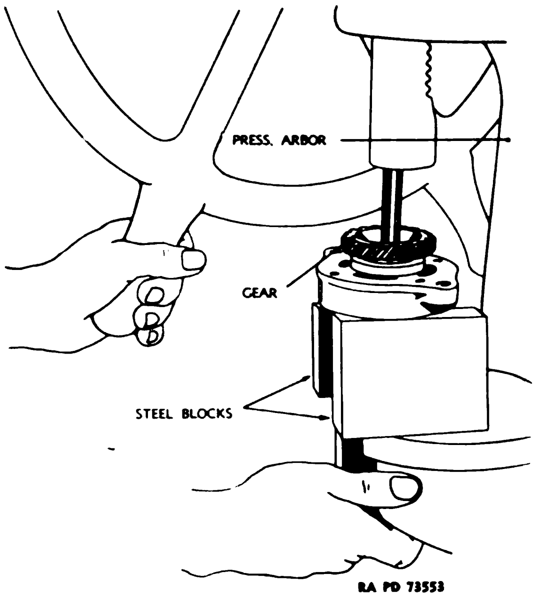

Figure 110 — Pressing Governor Drive Gear from Shaft

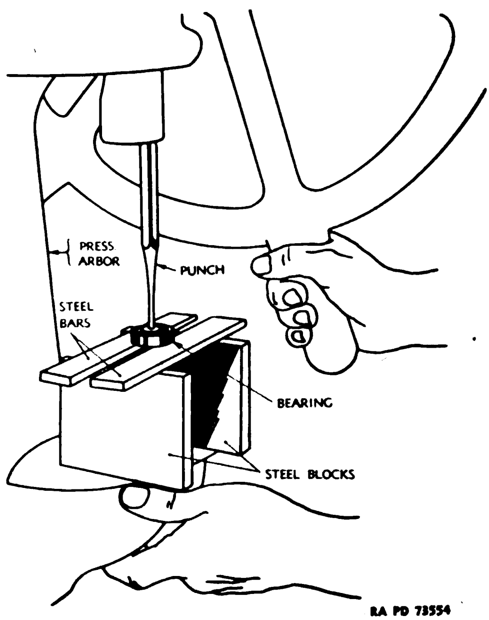

Figure 111 — Pressing Bearing and Sleeve from Shaft

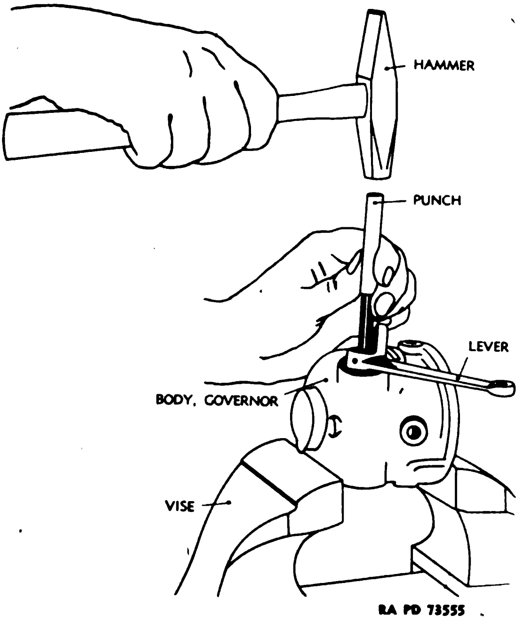

Figure 112 — Driving Rocker Shaft through Lever

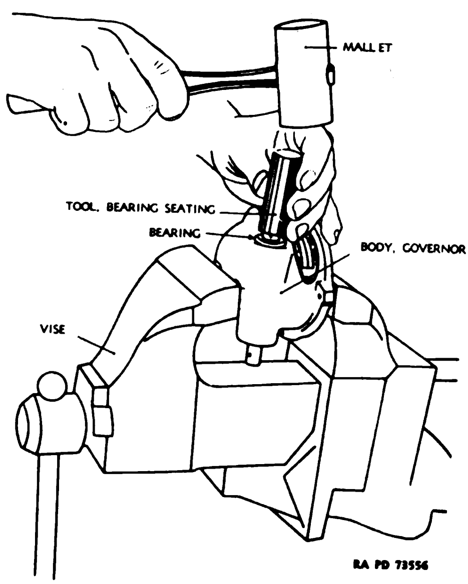

Figure 113 — Seating Bearings

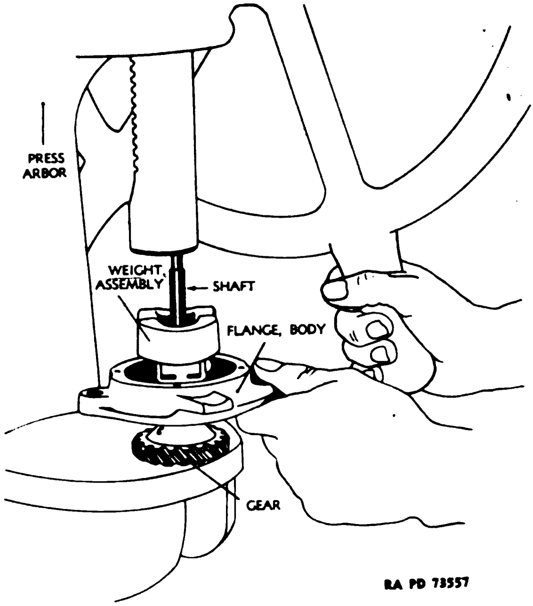

Figure 114 — Pressing Shaft into Drive Gear

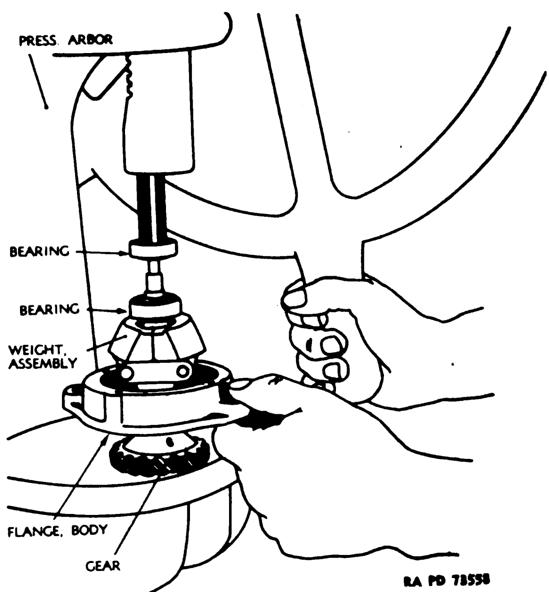

Figure 115 — End Bearing Installation

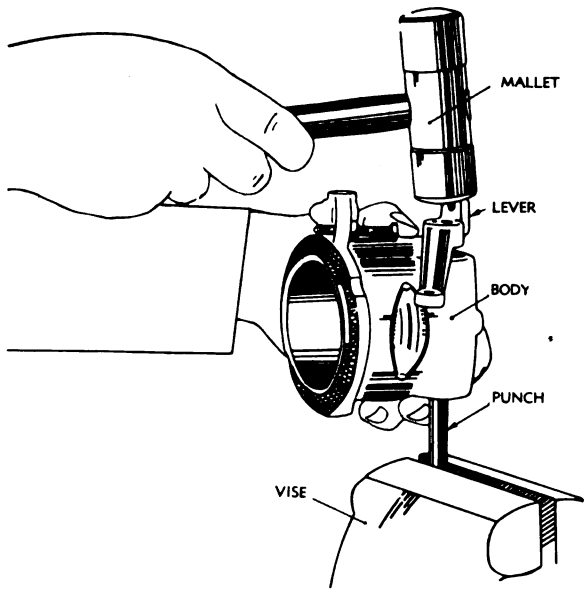

Figure 116 — Throttle Lever Installation

(8) LEVER AND ROCKER ARM. Inspect for damage, and replace if necessary.

(9) GOVERNOR AND FLANGE BODY. Inspect for cracks or breaks. Replace if defective.

48. GOVERNOR ASSEMBLY.

NOTE: The following special tool is required for assembly:
Bearing seating tool, Pierce governor.

a. Procedure.

(1) Put snap rings on rocker shaft. Install shaft in body without bearings, with the long end of the shaft toward the adjusting screw side. Install yoke on shaft with cap screws.

(2) Drive bearing on each end of shaft with letter side out. Seat bearings with mallet and governor bearing seating tool (fig. 113). Check rotation of shaft for friction. If bearings are correctly alined, rocker shaft should be free enough so that the yoke will fall of its own weight.

(3) Tap oil seal into place using governor bearing seating tool and mallet. Oil seal must be seated sufficiently tight to prevent leakage, but should not be hammered down against the bearing, as this will place excessive friction on the rocker shaft.

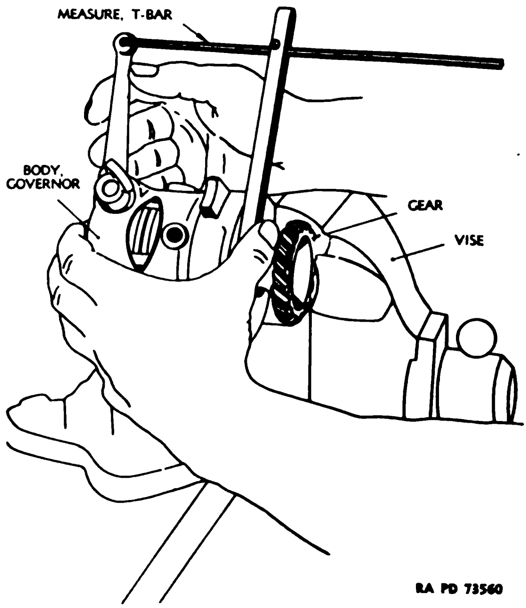

Figure 117 — Measuring Lever Distance from Body Flange

(4) Press front spider bearing on shaft.

(5) Press spider on shaft into position against bearing. Drill through spider and shaft with ⅛-inch drill, and pin with groove pin.

(6) Position weights in spider. Secure with weight pins. Slide thrust sleeve and bearing on shaft, and check thrust sleeve travel when weights are moved from closed to open position. Exploding weights into wide-open position must move the thrust sleeve ¼ inch on the shaft. If the sleeve does not lift the required ¼ inch, grind the weight stop tips that contact the spider hub when the weights are in wide-open position. When thrust sleeve movement is satisfactorily regulated, rivet the weight pin ends.

(7) Press shaft, bearings, and weight assembly into the governor flange. Care must be taken in pressing against end of drive shaft. Shaft is machined to very close tolerances, and can be easily sprung out of line. Use short interrupted strokes of the arbor press so that bearing can aline itself. Fasten bearing with the three bearing retaining screws and lock washers. Open weights to wide-open position, and rotate drive shaft to see that the weight stop tips clear the head of the bearing retaining screws. If clearance is not available, it will be necessary to grind the weight stop tip.

(8) Install Woodruff key in keyway of shaft, and press shaft into

gear (fig. 114). Drill through gear shank and spider shaft, and pin through with groove pin.

(9) Slide thrust sleeve with thrust bearing over shaft.

(10) Press bearing sleeve into ball bearing, and press this assembly on shaft with the bearing sleeve shoulder toward the weight assembly (fig. 115).

(11) Attach flange to body with the four fillister-head screws. Use a new gasket between flange and body.

(12) To install lever, back up the rocker shaft with a punch held in a vise (fig. 116), and tap on. Install lever with throttle rod end pointing toward the gear. Then, rotate so that the yoke in the body contacts the thrust bearing with the weights closed. Continue rotating in the same direction until the end of the lever is 3 $^{3}/_{16}$ inches from the body flange (fig. 117).

(13) Set welch plug in position on governor body at end of rocker arm hole. Tap into place.

(14) Install adjusting lever in position on governor body with shoulder stud. Install spring by hooking one end through eye of throttle lever eye bolt and the other end through hole in adjusting lever.

49. GOVERNOR INSTALLATION.

a. Procedure.

(1) Set governor into housing, and attach with cap screws and lock washers.

(2) While holding nut, install screw attaching governor arm to linkage.

(3) Engage oil line in compression fitting at top of governor.

50. GOVERNOR ADJUSTMENT (fig. 118).

a. Before making speed adjustment, back out antisurge screw at back of governor until only a few threads are engaged, and lock with lock nut.

b. Adjust engine speed at adjusting lever cap screw. Increasing tension on the governor screw increases engine revolutions per minute.

c. Adjusting spring eye in the throttle lever regulates governor sensitivity. Shortening the effective length of this screw, moving the spring eye toward the rocker shaft, increases governor sensitivity. Moving the spring eye away from the rocker shaft broadens regulation.

d. To dampen load surge, lengthen screw a turn or two at a time, until surge is eliminated.

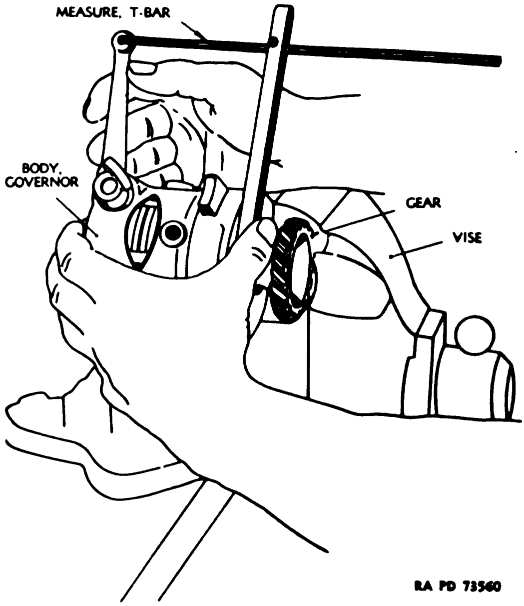

Figure 117 – Measuring Lever Distance from Body Flange

(4) Press front spider bearing on shaft.

(5) Press spider on shaft into position against bearing. Drill through spider and shaft with ⅛-inch drill, and pin with groove pin.

(6) Position weights in spider. Secure with weight pins. Slide thrust sleeve and bearing on shaft, and check thrust sleeve travel when weights are moved from closed to open position. Exploding weights into wide-open position must move the thrust sleeve ¼ inch on the shaft. If the sleeve does not lift the required ¼ inch, grind the weight stop tips that contact the spider hub when the weights are in wide-open position. When thrust sleeve movement is satisfactorily regulated, rivet the weight pin ends.

(7) Press shaft, bearings, and weight assembly into the governor flange. Care must be taken in pressing against end of drive shaft. Shaft is machined to very close tolerances, and can be easily sprung out of line. Use short interrupted strokes of the arbor press so that bearing can aline itself. Fasten bearing with the three bearing retaining screws and lock washers. Open weights to wide-open position, and rotate drive shaft to see that the weight stop tips clear the head of the bearing retaining screws. If clearance is not available, it will be necessary to grind the weight stop tip.

(8) Install Woodruff key in keyway of shaft, and press shaft into

gear (fig. 114). Drill through gear shank and spider shaft, and pin through with groove pin.

(9) Slide thrust sleeve with thrust bearing over shaft.

(10) Press bearing sleeve into ball bearing, and press this assembly on shaft with the bearing sleeve shoulder toward the weight assembly (fig. 115).

(11) Attach flange to body with the four fillister-head screws. Use a new gasket between flange and body.

(12) To install lever, back up the rocker shaft with a punch held in a vise (fig. 116), and tap on. Install lever with throttle rod end pointing toward the gear. Then, rotate so that the yoke in the body contacts the thrust bearing with the weights closed. Continue rotating in the same direction until the end of the lever is 3 $^{3}/_{16}$ inches from the body flange (fig. 117).

(13) Set welch plug in position on governor body at end of rocker arm hole. Tap into place.

(14) Install adjusting lever in position on governor body with shoulder stud. Install spring by hooking one end through eye of throttle lever eye bolt and the other end through hole in adjusting lever.

49. GOVERNOR INSTALLATION.

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(1) Set governor into housing, and attach with cap screws and lock washers.

(2) While holding nut, install screw attaching governor arm to linkage.

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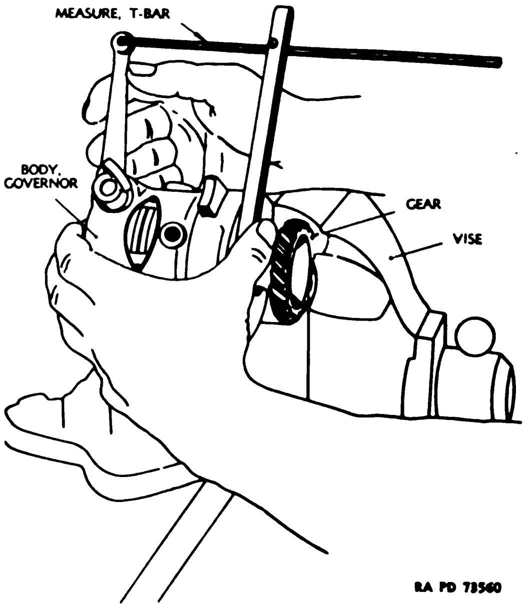

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50. GOVERNOR ADJUSTMENT (fig. 118).

a. Before making speed adjustment, back out antisurge screw at back of governor until only a few threads are engaged, and lock with lock nut.

b. Adjust engine speed at adjusting lever cap screw. Increasing tension on the governor screw increases engine revolutions per minute.

c. Adjusting spring eye in the throttle lever regulates governor sensitivity. Shortening the effective length of this screw, moving the spring eye toward the rocker shaft, increases governor sensitivity. Moving the spring eye away from the rocker shaft broadens regulation.

d. To dampen load surge, lengthen screw a turn or two at a time, until surge is eliminated.

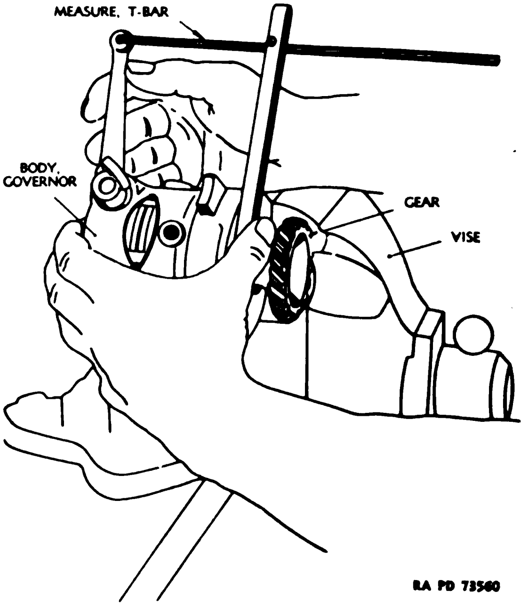

Figure 117 – Measuring Lever Distance from Body Flange

(4) Press front spider bearing on shaft.

(5) Press spider on shaft into position against bearing. Drill through spider and shaft with ⅛-inch drill, and pin with groove pin.

(6) Position weights in spider. Secure with weight pins. Slide thrust sleeve and bearing on shaft, and check thrust sleeve travel when weights are moved from closed to open position. Exploding weights into wide-open position must move the thrust sleeve ¼ inch on the shaft. If the sleeve does not lift the required ¼ inch, grind the weight stop tips that contact the spider hub when the weights are in wide-open position. When thrust sleeve movement is satisfactorily regulated, rivet the weight pin ends.

(7) Press shaft, bearings, and weight assembly into the governor flange. Care must be taken in pressing against end of drive shaft. Shaft is machined to very close tolerances, and can be easily sprung out of line. Use short interrupted strokes of the arbor press so that bearing can aline itself. Fasten bearing with the three bearing retaining screws and lock washers. Open weights to wide-open position, and rotate drive shaft to see that the weight stop tips clear the head of the bearing retaining screws. If clearance is not available, it will be necessary to grind the weight stop tip.

(8) Install Woodruff key in keyway of shaft, and press shaft into

gear (fig. 114). Drill through gear shank and spider shaft, and pin through with groove pin.

(9) Slide thrust sleeve with thrust bearing over shaft.

(10) Press bearing sleeve into ball bearing, and press this assembly on shaft with the bearing sleeve shoulder toward the weight assembly (fig. 115).

(11) Attach flange to body with the four fillister-head screws. Use a new gasket between flange and body.

(12) To install lever, back up the rocker shaft with a punch held in a vise (fig. 116), and tap on. Install lever with throttle rod end pointing toward the gear. Then, rotate so that the yoke in the body contacts the thrust bearing with the weights closed. Continue rotating in the same direction until the end of the lever is 3 $^{3}/_{16}$ inches from the body flange (fig. 117).

(13) Set welch plug in position on governor body at end of rocker arm hole. Tap into place.

(14) Install adjusting lever in position on governor body with shoulder stud. Install spring by hooking one end through eye of throttle lever eye bolt and the other end through hole in adjusting lever.

49. GOVERNOR INSTALLATION.

a. Procedure.

(1) Set governor into housing, and attach with cap screws and lock washers.

(2) While holding nut, install screw attaching governor arm to linkage.

(3) Engage oil line in compression fitting at top of governor.

50. GOVERNOR ADJUSTMENT (fig. 118).

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d. To dampen load surge, lengthen screw a turn or two at a time, until surge is eliminated.

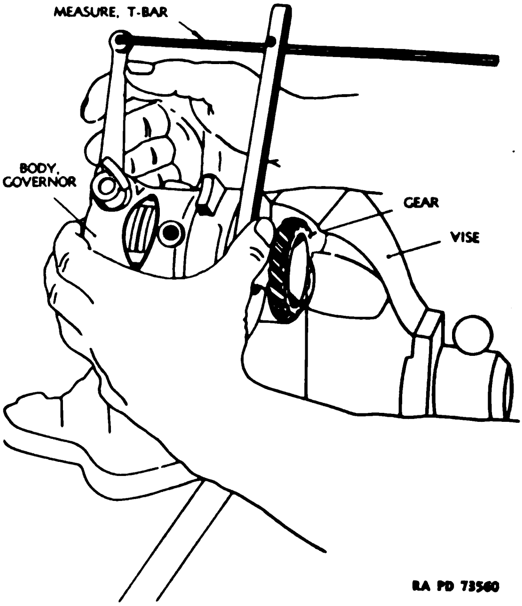

Figure 117 — Measuring Lever Distance from Body Flange

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(10) Press bearing sleeve into ball bearing, and press this assembly on shaft with the bearing sleeve shoulder toward the weight assembly (fig. 115).

(11) Attach flange to body with the four fillister-head screws. Use a new gasket between flange and body.

(12) To install lever, back up the rocker shaft with a punch held in a vise (fig. 116), and tap on. Install lever with throttle rod end pointing toward the gear. Then, rotate so that the yoke in the body contacts the thrust bearing with the weights closed. Continue rotating in the same direction until the end of the lever is 3 $^{3}/_{16}$ inches from the body flange (fig. 117).

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(14) Install adjusting lever in position on governor body with shoulder stud. Install spring by hooking one end through eye of throttle lever eye bolt and the other end through hole in adjusting lever.

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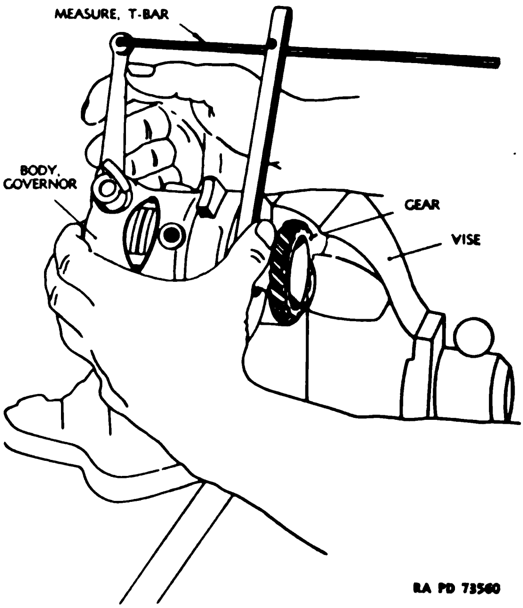

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(14) Install adjusting lever in position on governor body with shoulder stud. Install spring by hooking one end through eye of throttle lever eye bolt and the other end through hole in adjusting lever.

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d. To dampen load surge, lengthen screw a turn or two at a time, until surge is eliminated.

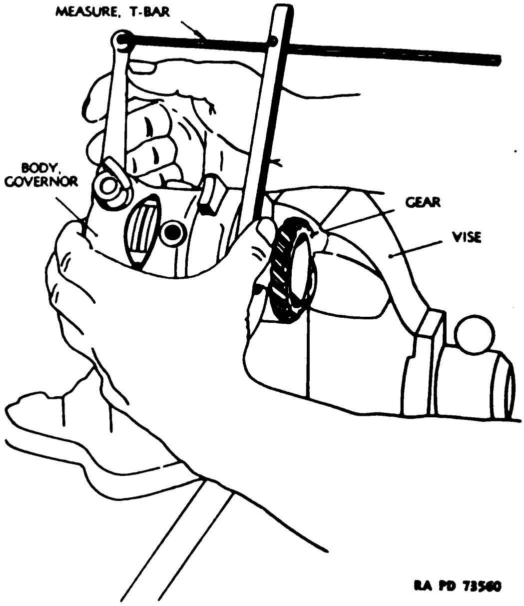

Figure 117 – Measuring Lever Distance from Body Flange

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(11) Attach flange to body with the four fillister-head screws. Use a new gasket between flange and body.

(12) To install lever, back up the rocker shaft with a punch held in a vise (fig. 116), and tap on. Install lever with throttle rod end pointing toward the gear. Then, rotate so that the yoke in the body contacts the thrust bearing with the weights closed. Continue rotating in the same direction until the end of the lever is 3 $\frac{3}{16}$ inches from the body flange (fig. 117).

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b. Adjust engine speed at adjusting lever cap screw. Increasing tension on the governor screw increases engine revolutions per minute.

c. Adjusting spring eye in the throttle lever regulates governor sensitivity. Shortening the effective length of this screw, moving the spring eye toward the rocker shaft, increases governor sensitivity. Moving the spring eye away from the rocker shaft broadens regulation.

d. To dampen load surge, lengthen screw a turn or two at a time, until surge is eliminated.

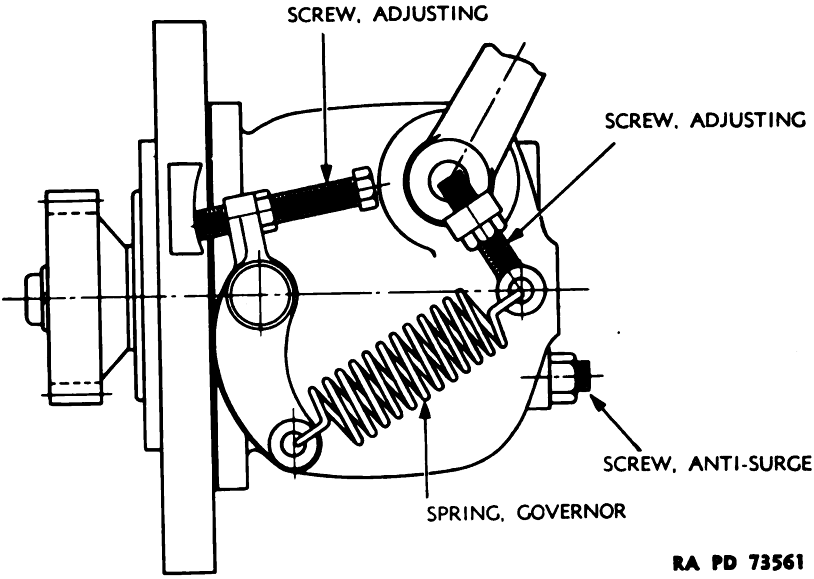

Figure 118 — Governor Adjusting Diagram

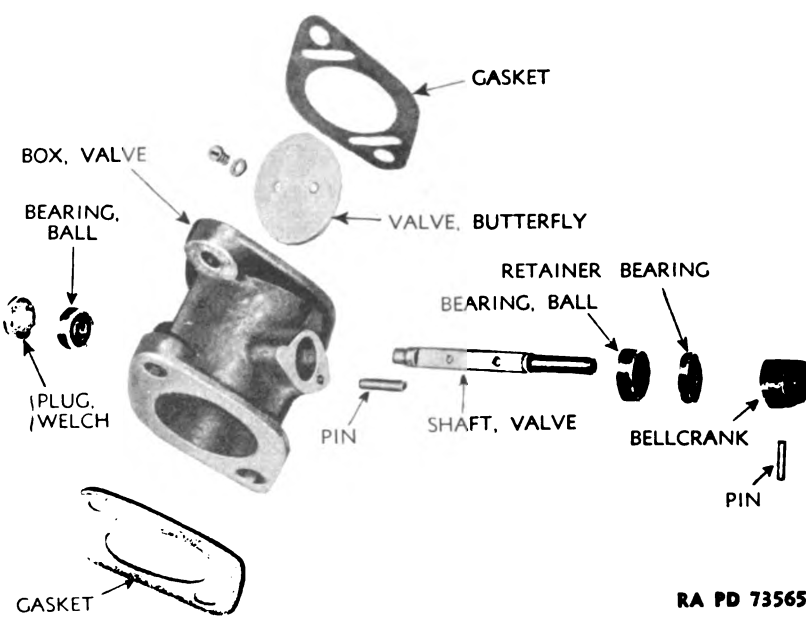

Figure 119 — Throttle Box — Exploded View

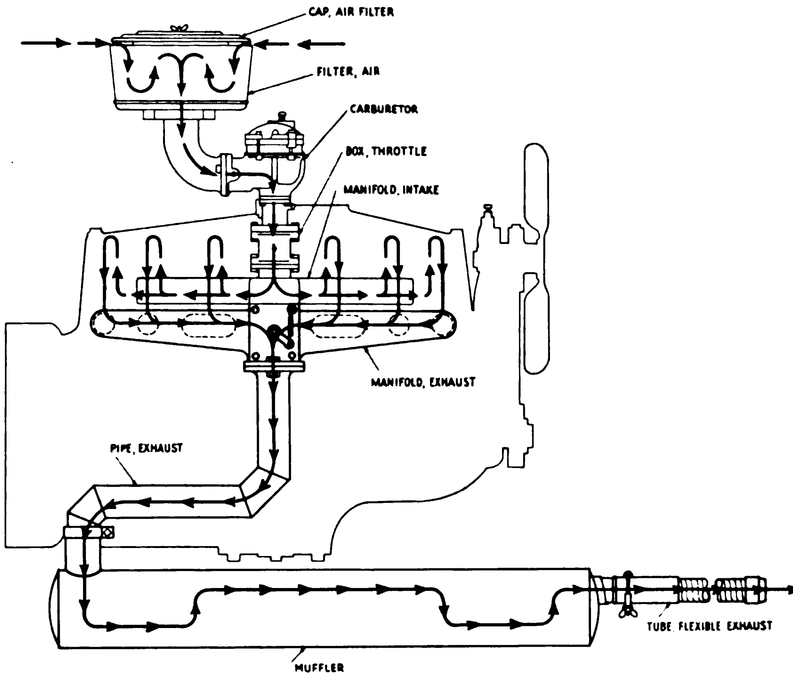

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Figure 120 — Intake and Exhaust System Diagram — Broken Arrows, Intake Air — Solid Arrows, Exhaust Gas

e. No-load surge is controlled by antisurge screw at back of governor. To eliminate no-load surge, screw bumper in a turn or two at a time until surging stops. Do not screw in far enough to increase engine speed. Antisurge screw is used only to eliminate a no-load surge, and should not be turned in unless necessary.

51. THROTTLE BOX DISASSEMBLY (fig. 119).

a. Procedure.

(1) File down the peened-over ends of the butterfly valve screws. Take out the screws, and remove the butterfly valve.

(2) Drive out crank pin. Drive shaft through bell crank. This will knock out end bearing and welch plug. Reverse shaft, and use as punch to knock out remaining bearing and bearing retainer.

52. THROTTLE BOX INSPECTION AND REPAIR.

a. Wash parts in SOLVENT, dry-cleaning, and make the following inspections.

(1) Check valve shaft for alinement. If out of alinement, straighten or replace.

(2) Inspect bell crank and throttle body for cracks. If defective, replace.

(3) Inspect bearings for excessive wear, and replace if necessary.

53. THROTTLE BOX ASSEMBLY.

a. Procedure.

(1) Press into position the bearing and bearing retainer on the bell crank side of the casting. Install shaft, and press in remaining bearing. Install welch plug.

(2) Install butterfly valve using new screws. Before tightening screws, rotate valve to closed position, and tap with screwdriver so that it will center. Tighten screws and peen over ends so they will not back out. When upsetting screws, be sure to back up the valve shaft with a wood block to avoid springing shaft out of line.

(3) Slide bell crank into position on shaft. With valve in wide-open position, push bell crank against stop pin. In this position, drill through crank and shaft, and pin with groove pin.

Section IV

EXHAUST SYSTEM

54. DESCRIPTION.

a. Construction. The exhaust system (fig. 120) is made up of the exhaust section of the manifold, the muffler, the pipe connection between muffler and manifold, and the detachable flexible tube that is attached to the outside end of the muffler when the unit is in operation.

b. Functioning. The burned gases, resulting from the ignition of the mixture of gasoline and air in the cylinder are forced by the exhaust stroke of the pistons out of the cylinders, into the manifold, and away from the unit by way of the exhaust pipe, the muffler, and the exhaust tube.

55. TROUBLE SHOOTING.

a. Manifold.

(1) EXHAUST FUMES.

Possible Cause	Possible Remedy
Leaking manifold gasket.	Tighten or replace.
Blown-out manifold gasket.	Replace.
Cracked manifold.	Replace.

b. Muffler.

(1) EXHAUST FUMES, EXCESSIVE NOISE.

Loose connections.	Tighten connections.
Opened seams.	Replace muffler.
Corroded metal.	Replace muffler.
Burned-out muffler.	Replace muffler.

56. MAINTENANCE AND REPAIRS.

a. Manifold (fig. 17).

(1) The manifold should be frequently inspected for cracks. When engine troubles develop that might have been caused by manifold cracks not apparent, the manifold should be removed and thoroughly inspected. Position and extent of cracks will determine whether the cracks can be welded or the manifold should be replaced.

(2) Bolts should be checked periodically for tightness. Collar gasket should be checked for condition. A worn gasket should be replaced. Always replace gasket after manifold has been removed.

b. Exhaust Pipe.

(1) Examine exhaust pipe regularly for cracks. Test welded joints. If cracks are found, replace pipe. If welded joints are broken, reweld.

(2) Test regularly for tightness of connections with muffler and manifold. Clean out at regular intervals.

c. Muffler. No repairs can be made on the muffler. If inspection finds cracks or evidence of burning out, replace.

Section V

LUBRICATION SYSTEM

57. DESCRIPTION (figs. 121 and 122).

a. The engine oil system provides continuous lubrication by means of a submerged-type gear pump driven from the camshaft. From the oil sump at the bottom of the crankcase, the pump draws oil through a strainer screen, and delivers it under pressure to the main oil gallery, drilled in the cylinder block on the side opposite the camshaft. From here the oil is sent, still under pressure, to the main and connecting rod bearings, front camshaft bearing, and governor. The rear and center camshaft bearings, cylinder walls, pistons, and valve tappets are all lubricated by oil thrown from the ends of the main and connecting rod bearings.

b. A certain amount of the oil delivered to the gallery is taken off through a bypass, sent through the oil filter, and back to the sump.

c. The oil pressure is automatically controlled or regulated by a compression spring which controls a relief or bypass valve. This device is located in the base of the oil filter.

58. TROUBLE SHOOTING.

a. **Excessive Oil Consumption.**

Possible Cause	Possible Remedy
Improper grade of oil.	Use proper grade.
Oil level too high.	Drain to proper level.
Excessive oil pressure.	Adjust oil pump.
Oil leaks.	Tighten gaskets and oil line fittings.

b. **Low Oil Pressure.**

Possible Cause	Possible Remedy
Improper grade of oil.	Use proper grade.
Lack of oil in crankcase.	Fill crankcase to proper level.
Relief valve stuck.	Remove valve, and service or replace.
Oil pump screen clogged.	Remove, and clean.
Oil pump worn.	Replace pump.

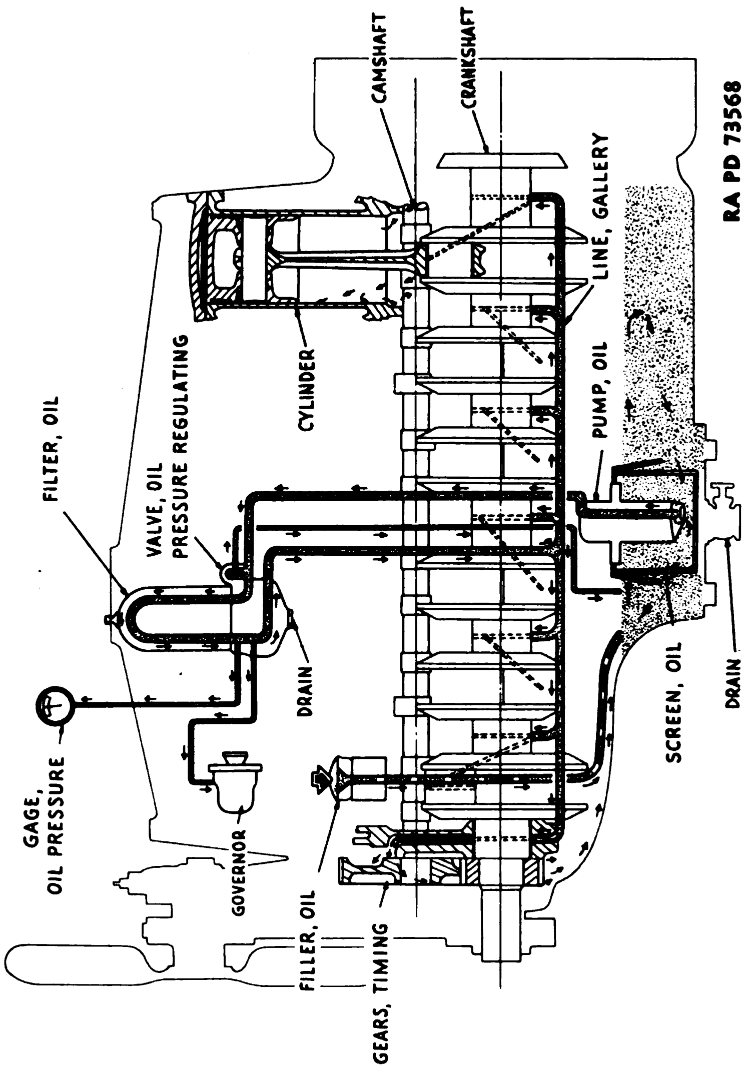

Figure 121 — Lubricating Oil System

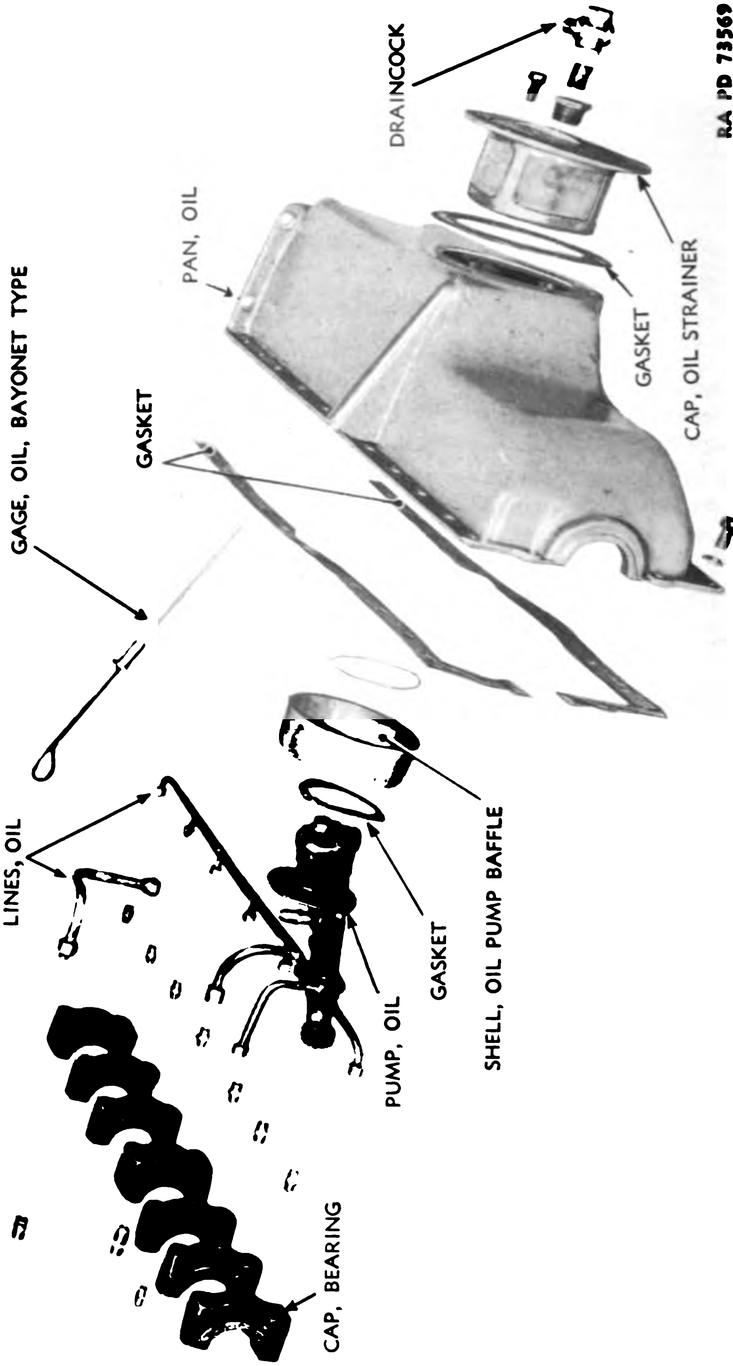

Figure 122 — Lubricating Oil System Details

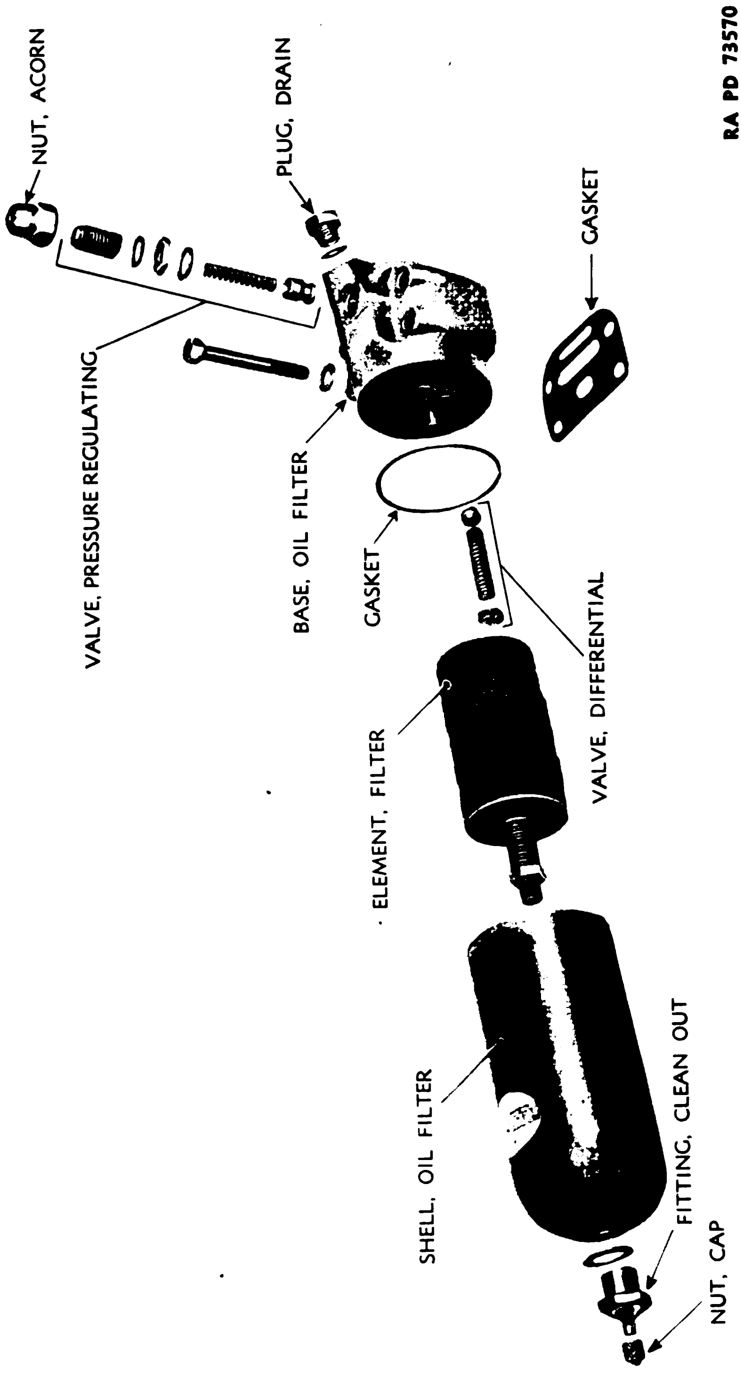

Figure 123 — Oil Filter Assembly — Exploded View

c. **Discolored Oil.**

Possible Cause	Possible Remedy
Clogged oil filter.	Service or replace filter.
Sludge in oil lines.	Remove and clean lines.
Sludge in oil pan.	Remove pan and clean.

59. OIL FILTER (fig. 123).

a. **Description.** The oil filter has a heavy-gage steel dome-shaped casing over a filter element made up of round felt pads about a center tube. The oil is pumped, under pressure, up through the filter pads. It comes out at the top and flows down through the filter tube, leaving dirt and other foreign substances on the bottom of the filter. A drain plug in the filter base allows sludge to be drained.

b. **Removal.** Take out four cap screws and lock washers holding filter base to engine block, and remove base and filter.

c. **Disassembly.**

(1) Unscrew hexagonal nut at top of shell, remove gasket, and take off casing.

(2) Unscrew element pipe at base, and lift off element.

(3) Remove acorn nut and gasket. Remove lock nut and gasket. Take out adjusting screw, and the spring will snap out. Turn filter base over, and the plunger will drop out.

(4) Take out screw, pull up spring, turn filter base upside down, and ball valve will shake out.

(5) Unscrew drain or sludge plug, and remove plug and gasket.

d. **Inspection and Repair.**

(1) Wash all parts thoroughly in SOLVENT, dry-cleaning, and dry with compressed air.

(2) Examine all springs for rust or signs of corrosion. Replace, if corroded, bent, or broken.

(3) Inspect screws, nuts, and valves for excessive wear, stripped threads, or breaks. Replace any faulty parts.

(4) Examine shell and filter base for cracks or breaks. Replace if necessary.

(5) Check gaskets, and replace if worn or damaged.

e. **Assembly.**

(1) Drop valve ball into tapped valve hole, follow with spring, and install spring holding screw.

(2) Screw down threaded end of element tube into center tapped hole of filter base.

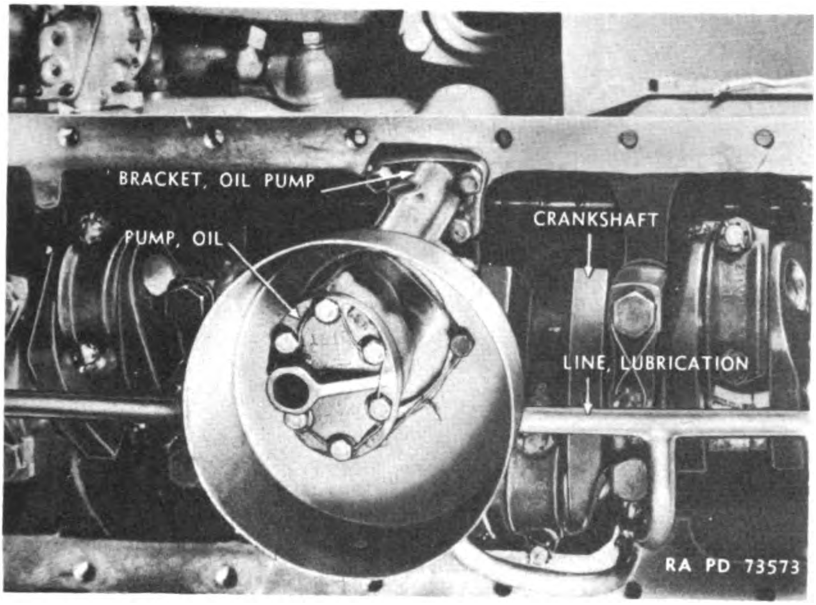

Figure 124 — Oil Pump

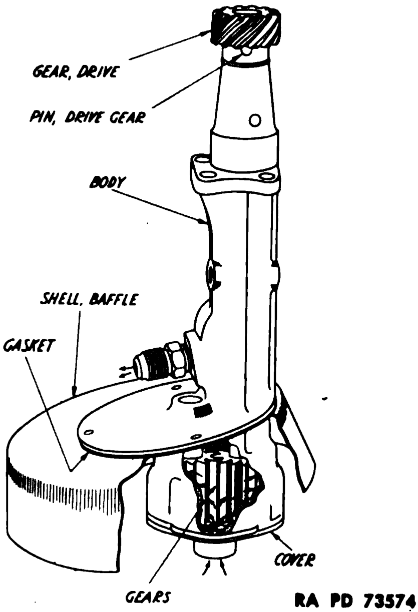

Figure 125 — Oil Pump Diagram

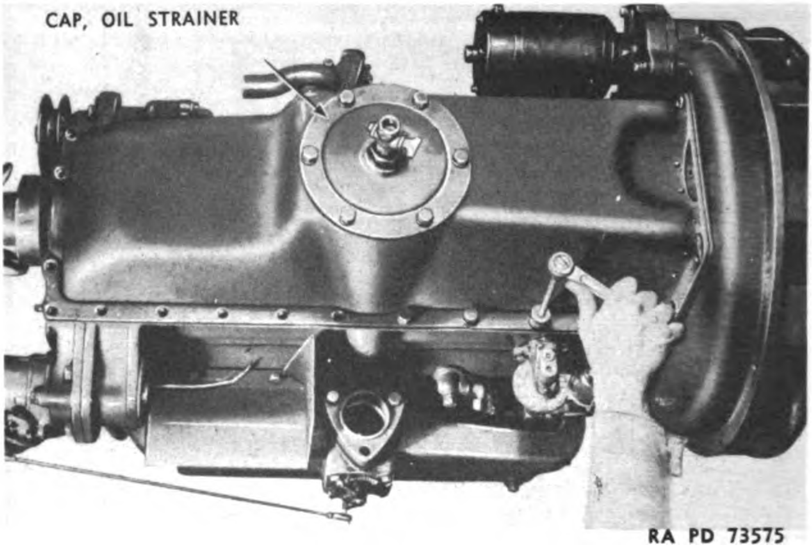

Figure 126 — Oil Pan Removal

(3) Bring filter shell down on element and base with gasket in place. Set gasket in place at top of shell, and screw on clean-out fitting with cap nut in place.

(4) Install drain plug and gasket at base of filter.

(5) Drop plunger into valve hole, hollow end up. Install spring on top of plunger. Hold gasket and lock nut on top of hole and install adjusting screw. Spin second gasket onto screw and cover with acorn nut.

f. **Installation.** Attach oil filter base to engine block over gasket with four cap screws.

g. **Servicing.**

(1) Take out sludge drain plug in bottom of filter and drain sludge.

(2) With sludge plug removed, remove cap nut from top of filter, and blow out the filter with compressed air.

(3) Remove clean-out fitting at top of shell, and remove shell. Scrape all sludge and foreign matter from the filter element with wood paddle.

h. **Oil Pressure Regulating Valve** (fig. 123).

(1) REMOVAL. Refer to procedure outlined in subparagraph c (3) above.

(2) INSPECTION AND REPAIR. Refer to procedure outlined in subparagraph d above.

(3) ASSEMBLY. Refer to procedure outlined in subparagraph e (5) above.

(4) ADJUSTMENT.

(a) Take off acorn nut and gasket, and loosen lock nut holding adjusting screw.

(b) The adjusting screw shall be turned until the oil pressure gage on the instrument panel registers 25 pounds pressure at 1,200 rpm. Tightening the screw increases the pressure, loosening the screw decreases pressure. NOTE: The oil pressure should not be changed or judged to be too high or too low until it is known that the proper weight of oil is being used, and the engine is warmed up to normal operating temperature. As the bearings become worn, more oil will escape around the bearings into the case, and this will lower the pressure slightly. It is not advisable to try to correct this slight loss of pressure by an adjustment of the pressure regulating valve because the extra amount of oil being thrown off by the worn bearings is already overoiling the cylinder walls.

60. OIL PUMP (figs. 124 and 125).

a. Description. The oil pump is of the positive spur gear type, and is submerged in the oil pan. It is gear-driven from the camshaft. In operation, oil is drawn from the oil pan, through the pump and to the main oil gallery in the cylinder block.

b. Removal.

(1) Block unit up, high enough to remove oil pan.

(2) Remove oil pan (par. 22 a (9)) (fig. 126).

(3) Remove oil pump (par. 22 a (10)) (fig. 40).

c. Disassembly (fig. 127).

(1) Remove wire securing baffle shell cap screws together. Take out cap screws holding baffle shell to oil pump body, and remove baffle shell and gasket.

(2) Take out wire fastening cover plate cap screws together. Remove cap screws. Take out snap rings holding spur gears to shafts, and remove gears and idler shaft.

(3) File down peened-over end of drive gear pin, drive out pin, and slide gear and washer from shaft, and shaft from oil pump body.

d. Inspection and Repair.

(1) Check oil pump drive shaft for wear or damage. Replace if necessary.

(2) Try fit of oil pump drive shaft in body. It should be a free running fit without side play. Replace oil pump drive shaft or body if worn.

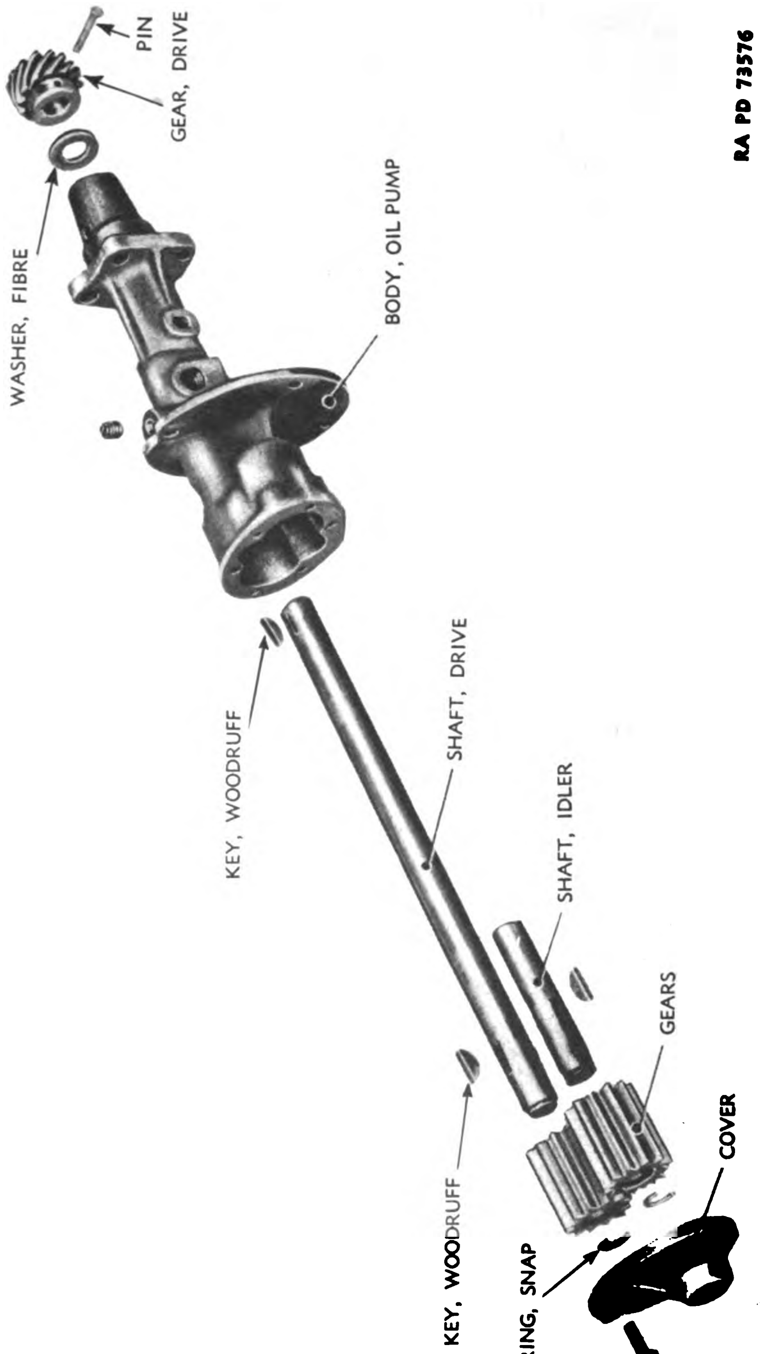

Figure 127 — Oil Pump Details

(3) Inspect condition of all oil pump gears. Replace damaged gears.

(4) Inspect condition of oil pump gear keys. Replace damaged keys.

e. **Assembly.**

(1) Press drive shaft up through pump body. Install new fiber washer over drive end. Insert Woodruff key in position in shaft slot. Press drive gear onto shaft until pin hole in gear collar lines up with hole through shaft. Insert new pin through gear and shaft and peen-over end.

(2) Place Woodruff key in position in drive shaft slot. Press gear over end of shaft, and secure with snap ring in shaft groove. Place Woodruff key in position in idler shaft, press on gear, and secure with snap ring in idler shaft groove. Insert idler shaft into pump body.

(3) Place oil pump cover in position, and secure to pump with cap screws. Wire the screw heads together.

(4) Place baffle shell in position over gasket on body plate. Secure with cap screws. Wire screw heads together.

f. **Installation.**

(1) Install oil pump (par. 24 a (14)).

(2) Attach oil pan (par. 24 a (16)).

Section VI

ELECTRICAL SYSTEM — BATTERY-CHARGING GENERATOR, REGULATOR, AND BATTERY

61. DESCRIPTION.

a. **Battery-charging Generator Circuit** (fig. 129).

(1) The battery-charging generator circuit consists of a generator, regulator, ammeter, battery, and connecting wires.

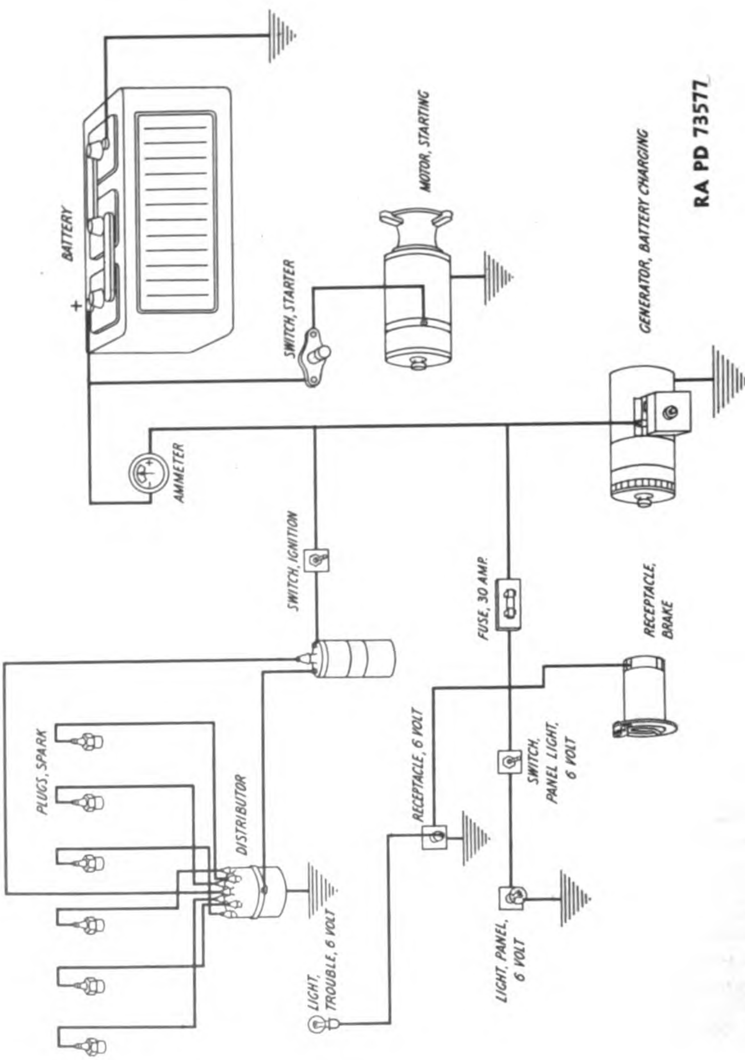

Figure 128 — Engine Electrical System

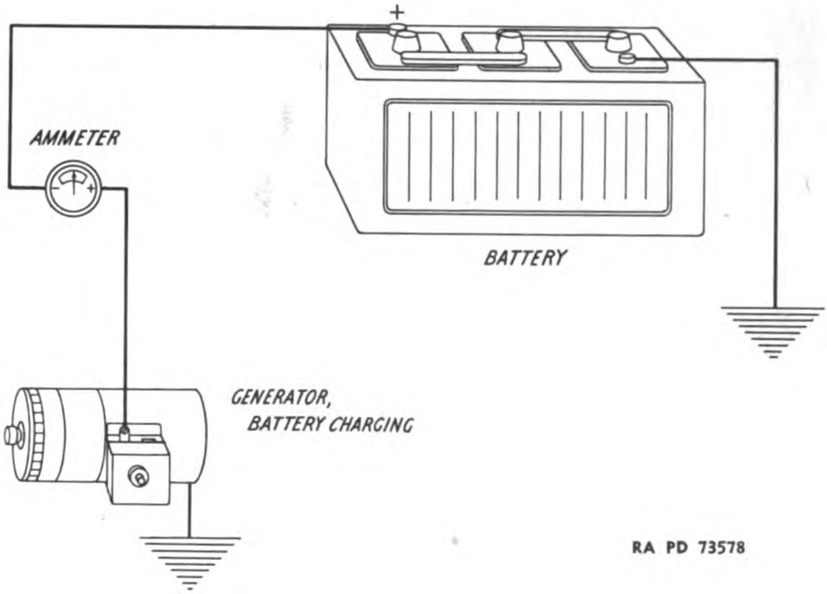

Figure 129 — Engine Electrical System — Generator Circuit

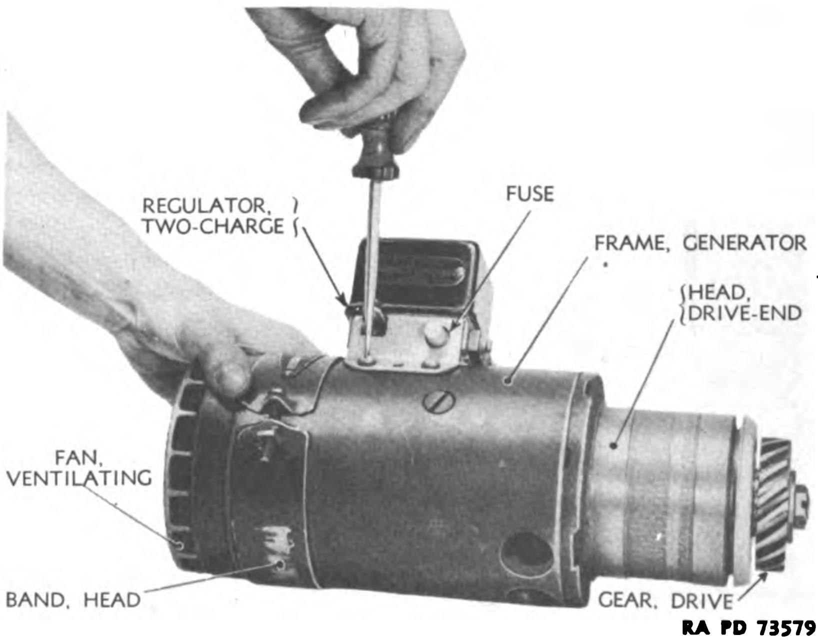

Figure 130 — Battery-charging Generator Regulator Removal

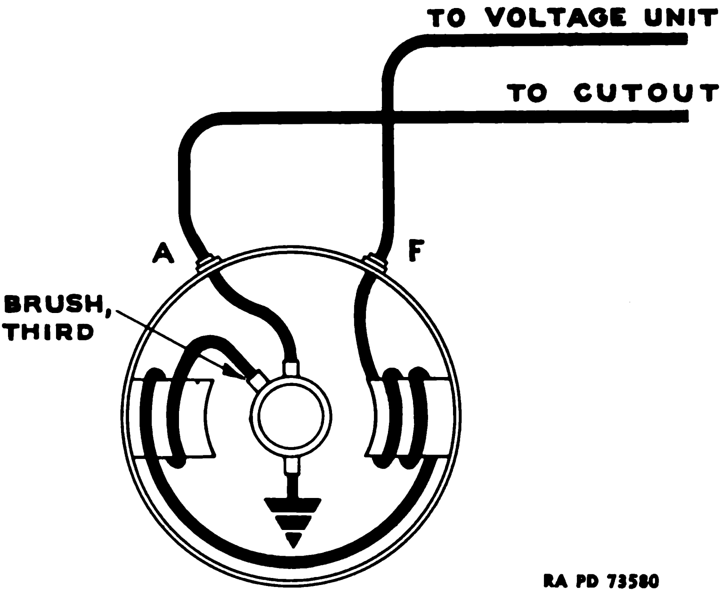

Figure 131 — Generator Wiring Diagram

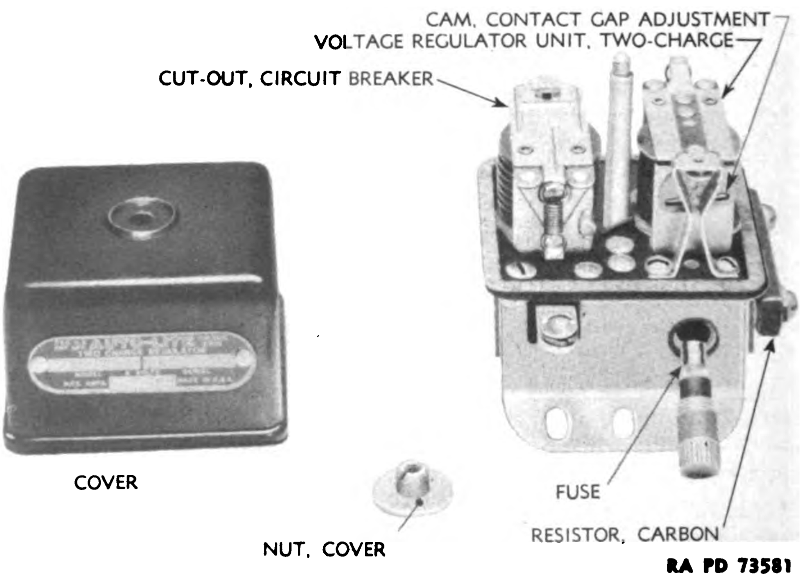

Figure 132 — Generator Regulator

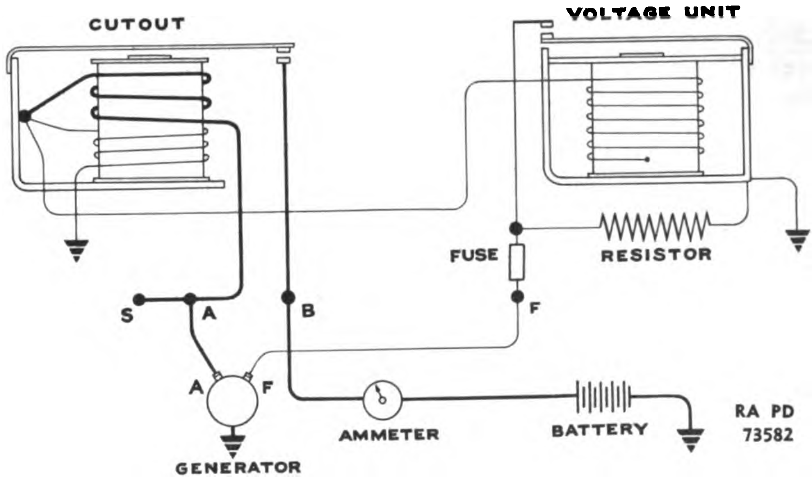

Figure 133 — Generator Regulator Wiring Diagram

(2) Its function is to convert a small amount of mechanical energy from the engine into electrical energy, and store it for future use. This electrical energy, produced by the generator, is carried from the generator through the wiring to the storage battery. In actual operation, some of the energy may be used directly from the generator.

b. **Battery-charging Generator** (figs. 130 and 131).

(1) The generator is a device for changing mechanical energy into electrical energy. It consists of four main subassemblies which are the frame and field, the armature, the commutator end plate, and the drive end head.

(2) The frame and field consist of the iron shell which supports the units, and also forms part of the magnetic circuit and the field coils which supply the magnetic field. The field coils are mounted on pole pieces which hold the coils in place, and also distribute the flux so that it flows evenly through the armature core and back through the frame. The armature is composed of the shaft, laminated iron core, the commutator, and the armature coils. The coils are wound in slots in the armature core, and the ends of the coils are clinched and soldered to the commutator bars. The commutator is composed of copper wedges insulated from each other and from the shaft. The drive end head provides the support for the ball bearing and also supplies the mounting flange. The commutator end plate also supports a ball bearing, and provides the support for the brush plates and arms. The brushes are mounted in these plates, and are held against the commutator by the brush springs and arms.

(3) To produce electrical energy, it is necessary to turn the armature. This causes the windings of the armature to cut the magnetic flux produced by the field coils. This cutting of a magnetic field by an electrical conductor produces a voltage in the armature conductors. The commutator and brushes are arranged so that the generated voltage is carried from the revolving armature to the armature terminal outside the generator. A small fraction of the current produced by the generator is bypassed through the field coils to produce the magnetic field. The output of the generator is determined by the strength of the field and by the speed of the armature in cutting through the field. Since the speed of the generator cannot be regulated, the control of the generator output is accomplished by changing the field current. This is done by the action of the generator regulator.

(4) The generator windings are cooled by the action of a centrifugal fan mounted on the commutator end of the armature shaft. This fan draws air into the generator through the openings on the under side of the frame. The air passes over the armature and field windings, and through the holes in the commutator end plate, where it is expelled by the fan.

c. **Generator Regulator** (figs. 132 and 133).

(1) The generator regulator is a combination circuit breaker and voltage regulator. The circuit breaker automatically opens and closes the circuit between generator and storage battery.

(2) The circuit breaker consists of an electromagnet and a set of contacts. The electromagnet has two windings; in one, a shunt coil, made of many windings, is connected across the generator; in the other, a series coil made of fewer turns of heavy wire, is connected in series with the generator output. The circuit breaker contacts consists of one movable contact mounted on an armature operated by the electromagnet, while the other is a stationary contact. These contacts are held open by an armature spring to prevent battery discharge through the generator.

(3) When the generator is not running, the contacts are open. When the generator is started, the voltage builds up at the generator terminal and in the shunt coil, since the shunt coil offers resistance to the current flow. As soon as the voltage reaches the value for which the circuit breaker is calibrated, there is sufficient magnetism created by the shunt coil to pull down the armature, closing the contacts, and automatically connecting the generator to the battery.

(4) With the contacts thus closed, the current which meets less resistance, in the series coil, flows from the generator to the battery, or in the same direction as the current in the shunt coil, so that the pull on the armature is increased by magnetism of the series coil.

(5) As the engine is stopping and the generator loses speed, the voltage falls. As soon as the generator voltage drops below the battery terminal voltage, the current flows from the battery to the generator, reversing the direction of current in the series coil. Then the magnetism created by the series coil is opposed to the magnetism created by the shunt coil. This reduces the magnetic pull on the armature, and the spring opens the contacts, disconnecting the generator from the battery.

(6) The voltage regulator operates on the principle of inserting a resistance in the generator field circuit when the generator voltage reaches a predetermined value. This consists of an electromagnet, a set of contacts, and a resistor, so arranged that the contacts are normally closed and the generator field circuit passes through the contacts to ground. When the contacts are opened, through the action of the electromagnet, the generator field circuit must pass through the resistor before going to ground. This is accomplished by connecting the electromagnet to the generator current at the circuit breaker. When the battery is low, it offers little resistance to the generator current, but as the battery approaches full charge and can not take the full generator current, the voltage is built up to the point at which the voltage regulator electromagnet is calibrated. The current flows through the electromagnet, opening the contacts and inserting the resistor in the generator field circuit. This cuts down the strength of the field, which reduces the generator output, and prevents the battery from being "overcharged."

(7) To meet battery characteristic changes resulting from temperature changes, a magnetic bypass is used. The magnetic bypass type of compensation operates by varying the amount of magnetic pull exerted on the armature at any given voltage, according to the temperature.

(8) The magnetic bypass is a small piece of nickel-iron across the top of the magnetic core of the electro-magnet. The magnetic conductivity of this bypass gradually increases as its temperature is reduced. Thus, at low temperatures, much of the magnetic pull of the core, which would normally affect the cutting-in of the field resistance, flows through this bypass instead of the regular armature. This results in a higher generator voltage being required to open the contacts and cut in the field resistance.

(9) At high temperatures the magnetic conductivity of the bypass is reduced, thus allowing the magnetic pull of the core to have full effect on the regulator armature and cut in the field resistance at a lower generator voltage.

62. TROUBLE SHOOTING.

a. Low or No Generator Output.

Possible Cause	Possible Remedy
Dry battery.	Refill cells (par 68).
Poor battery condition.	Replace battery.
Loose connections.	Tighten connections.
Dirty connections.	Clean and tighten connections.
Burned contacts on regulator.	Clean or repair contacts (par. 66 d (4)).

b. High Discharge Ammeter.

Regulator or circuit breaker closed.	Repair or adjust circuit breaker (par. 66 d (7)).

c. Noise at Engine Idle Speed.

Broken bearing.	Replace bearing (pars. 63 and 65).
Loose pole piece.	Tighten pole piece (par. 65).
Commutator damaged.	Repair commutator or replace armature (pars. 63 and 64).

d. Low Charging Rate.

Dirty commutator.	Clean commutator (par. 64 a (2) (c)).
Voltage regulator improperly adjusted.	Adjust regulator (par. 66 d).
High resistance in charging circuit.	Clean and tighten battery terminals, and check circuit for loose connections.
Third brush improperly adjusted.	Adjust for correct charging rate by moving brush holder in direction of armature rotation.

e. High Charging Rate.

Third brush improperly adjusted.	Adjust for lower charging rate by moving brush holder in direction opposite armature rotation.

63. GENERATOR DISASSEMBLY (fig. 134).

a. Procedure.

(1) Take out the four screws holding the regulator to the generator. Take out the two screws holding generator leads to regulator, and remove leads and regulator.

(2) Unscrew bolt holding ends of head band cover strip together, and remove bolt and head band.

(3) Take out cotter pin holding castellated shaft nut in place. Remove nut. Remove drive gear.

(4) Take off shaft nut. Remove fan.

(5) Take out screws holding the air deflector to the commutator head, and remove the deflector. Remove washers.

(6) Take out screws attaching leads from field coils to brush holders, and remove leads.

(7) Take out the frame screws, and remove the commutator end head.

(8) Force back brush holder springs and spring clamps, and slide clamps and springs from posts. Take out screw attaching third brush-holding ring yoke to head, and remove yoke and brush-holding ring.

(9) Separate drive end head and armature from body, and press out armature.

(10) Take off cover plate. Press out head bearing.

(11) Press out commutator end bearing.

(12) Take out the two screws through the generator body to the pole pieces, and remove the field coils and pole pieces.

64. GENERATOR INSPECTION AND REPAIR.

a. Procedure.

(1) FIELD COIL TESTS.

(a) Place test prod leads on the two leads from one field coil. If the test lamp lights, the field coil has no open circuit. If lamp does not light, the field coil is open-circuited, and should be replaced. Proceed in the same manner to test the other field coil.

(b) Connect a field coil to a battery in series with a testing ammeter. Take a reading on ammeter. Repeat the procedure on the other field coil. If one field coil draws more current than the other, there is an internal short in the field coil that draws the most current, and it should be replaced.

(2) ARMATURE TESTS.

(a) Place one test prod lead on armature, and the other on one of the commutator bars (fig. 135). If test lamp lights, armature is grounded, and should be replaced. If test lamp does not light, armature is not grounded. Proceed to test each commutator bar in turn until all have been tested.

(b) Place armature on growler and, with a hack saw over armature core, rotate armature and test (fig. 136). If saw blade does not vibrate, armature has no shorts. If saw blade vibrates, armature is short-circuited. To determine whether armature windings or the commutator is shorted, clean out between commutator bars, and recheck aramature. If the saw blade still vibrates, armature windings are short-circuited. Armature must be replaced.

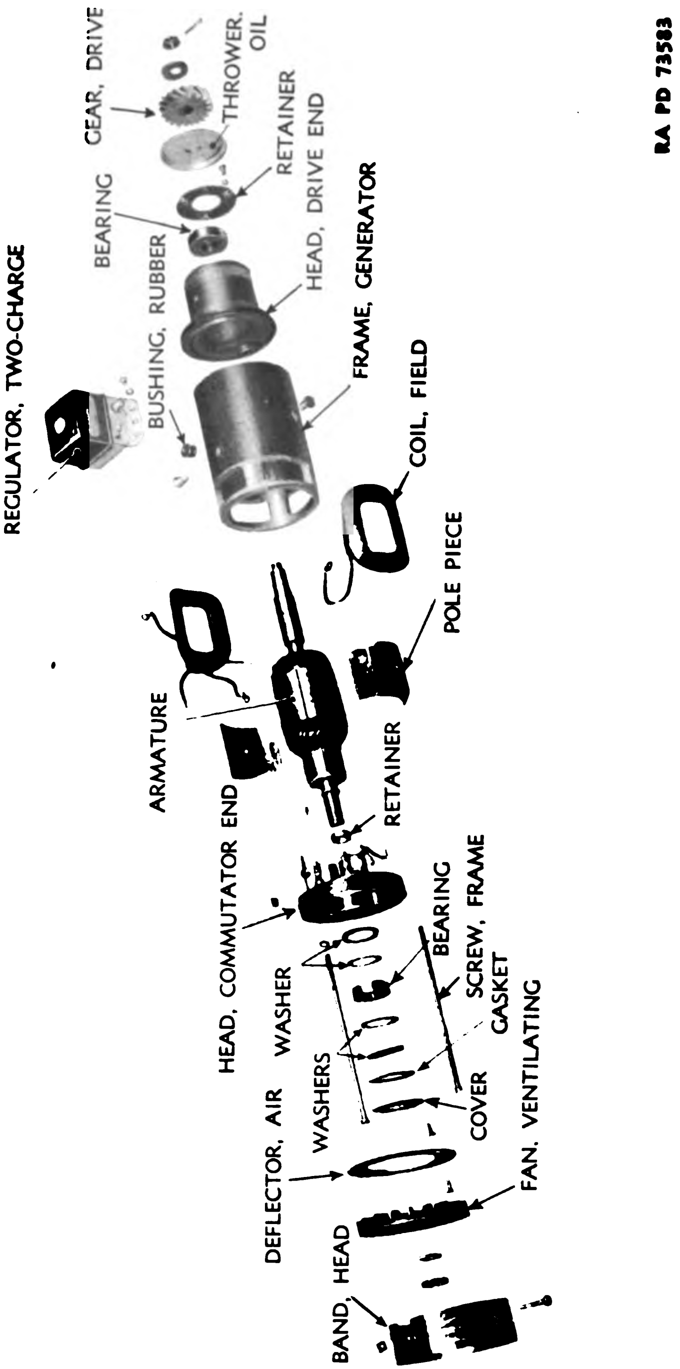

Figure 134 — Generator — Exploded View

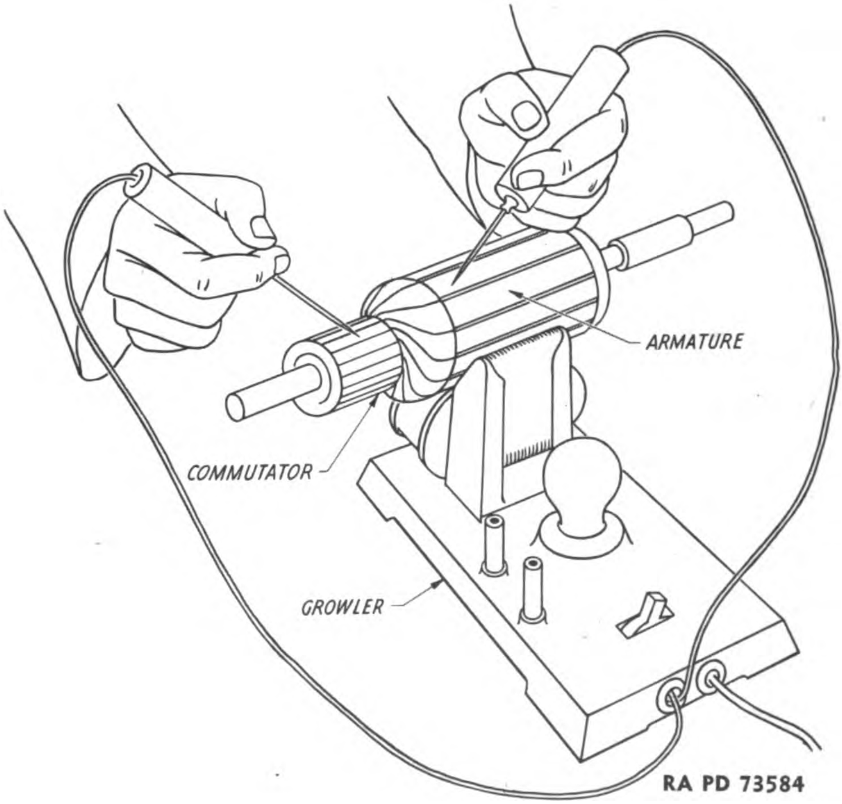

Figure 135 — Testing Commutator Bars

(c) Check the commutator for roughness, and if rough, turn it down on a lathe until it is thoroughly clean, after which dress with PAPER, flint, class B, No. 2/0. Undercut the mica (fig. 137), and again check armature on growler for shorts.

(d) Check armature to commutator leads. See that they are properly soldered to commutator.

(3) General Tests.

(a) Check fit of armature shaft in commutator end bearing. If bearing is worn, replace it.

(b) Clean ball bearings in SOLVENT, dry-cleaning, and blow out with compressed air. Check bearings for wear or roughness. Replace if necessary.

(c) Check to see that brush springs have enough tension to hold brushes snugly against the commutator. Replace if necessary.

(d) Check brushes for wear and condition. Replace if worn to half their original length, or if broken.

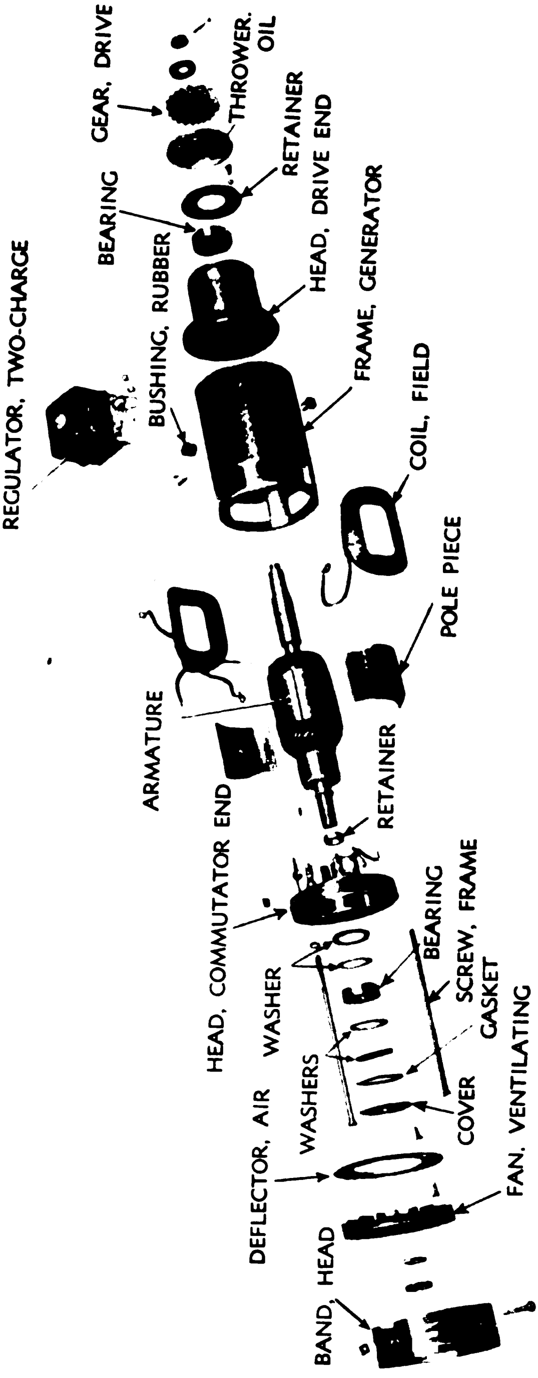

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Figure 134 — Generator — Exploded View

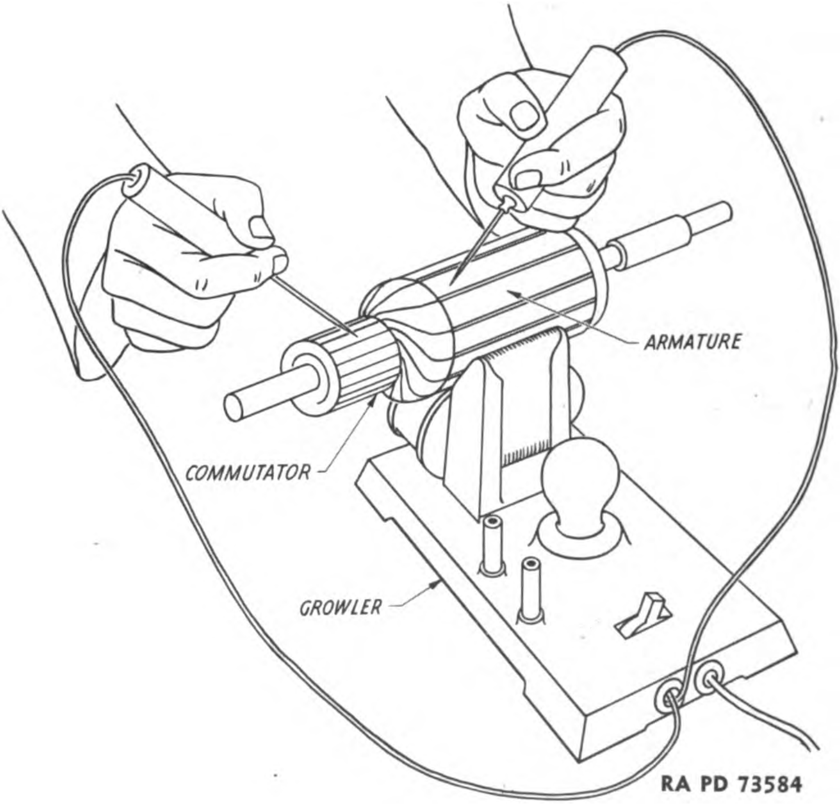

Figure 135 — Testing Commutator Bars

(c) Check the commutator for roughness, and if rough, turn it down on a lathe until it is thoroughly clean, after which dress with PAPER, flint, class B, No. 2/0. Undercut the mica (fig. 137), and again check armature on growler for shorts.

(d) Check armature to commutator leads. See that they are properly soldered to commutator.

(3) GENERAL TESTS.

(a) Check fit of armature shaft in commutator end bearing. If bearing is worn, replace it.

(b) Clean ball bearings in SOLVENT, dry-cleaning, and blow out with compressed air. Check bearings for wear or roughness. Replace if necessary.

(c) Check to see that brush springs have enough tension to hold brushes snugly against the commutator. Replace if necessary.

(d) Check brushes for wear and condition. Replace if worn to half their original length, or if broken.

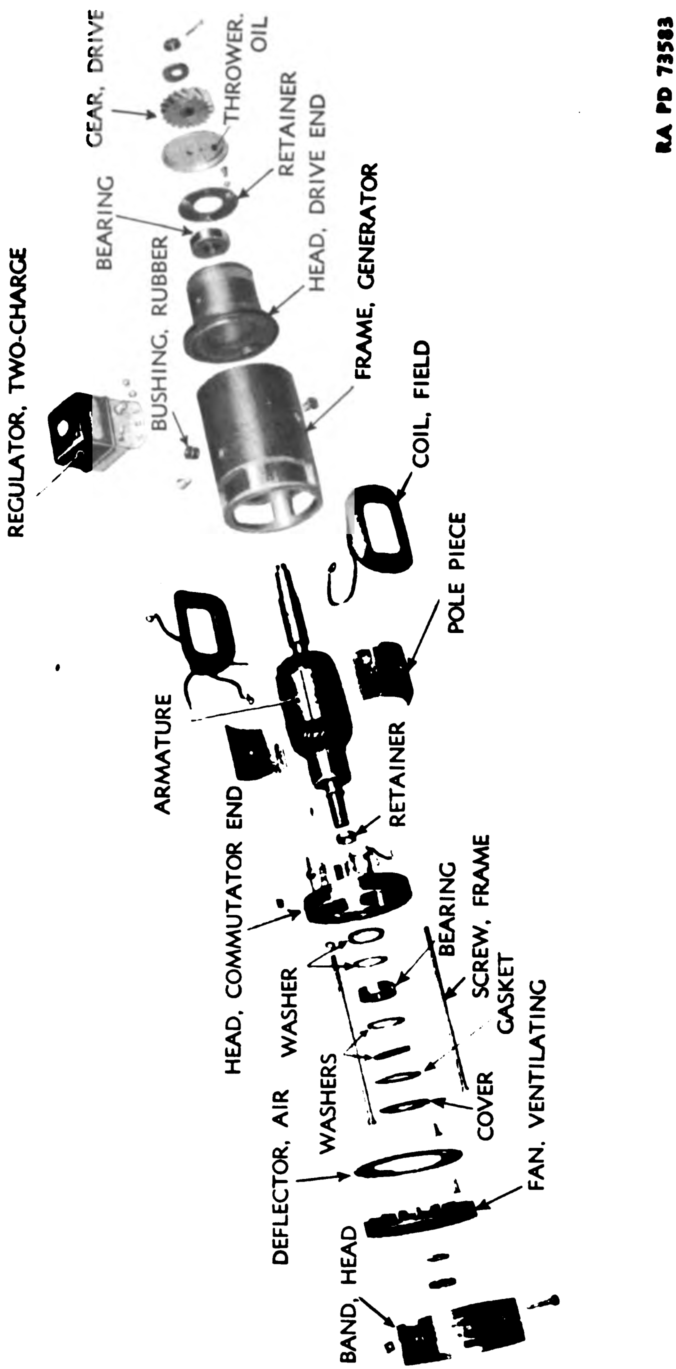

Figure 134 — Generator — Exploded View

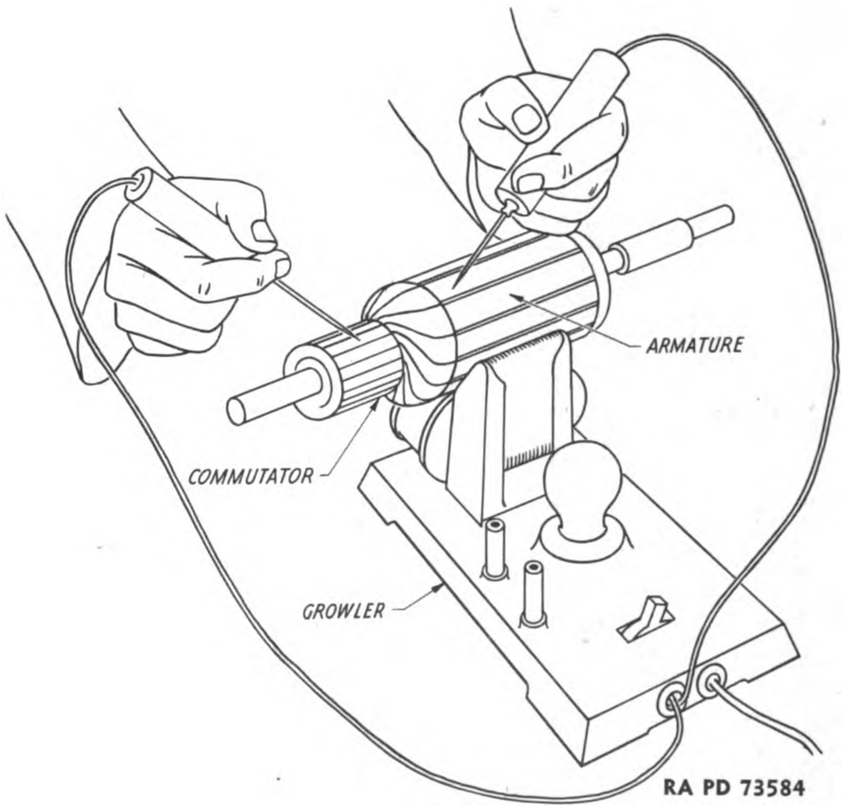

Figure 135 — Testing Commutator Bars

(c) Check the commutator for roughness, and if rough, turn it down on a lathe until it is thoroughly clean, after which dress with PAPER, flint, class B, No. 2/0. Undercut the mica (fig. 137), and again check armature on growler for shorts.

(d) Check armature to commutator leads. See that they are properly soldered to commutator.

(3) GENERAL TESTS.

(a) Check fit of armature shaft in commutator end bearing. If bearing is worn, replace it.

(b) Clean ball bearings in SOLVENT, dry-cleaning, and blow out with compressed air. Check bearings for wear or roughness. Replace if necessary.

(c) Check to see that brush springs have enough tension to hold brushes snugly against the commutator. Replace if necessary.

(d) Check brushes for wear and condition. Replace if worn to half their original length, or if broken.

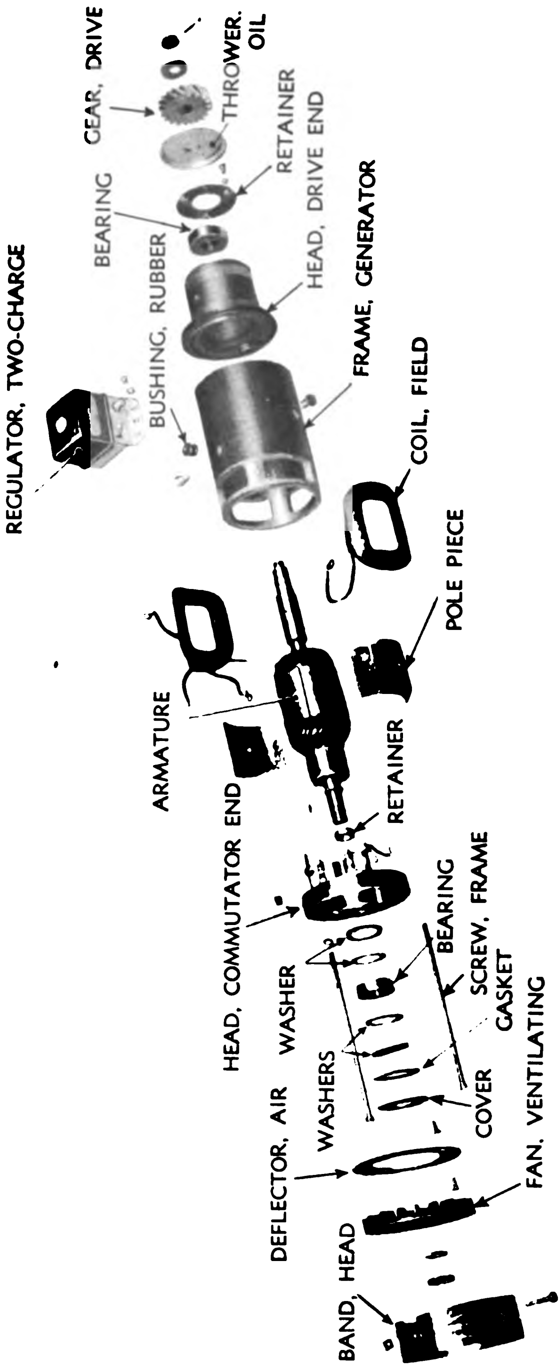

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Figure 134 — Generator — Exploded View

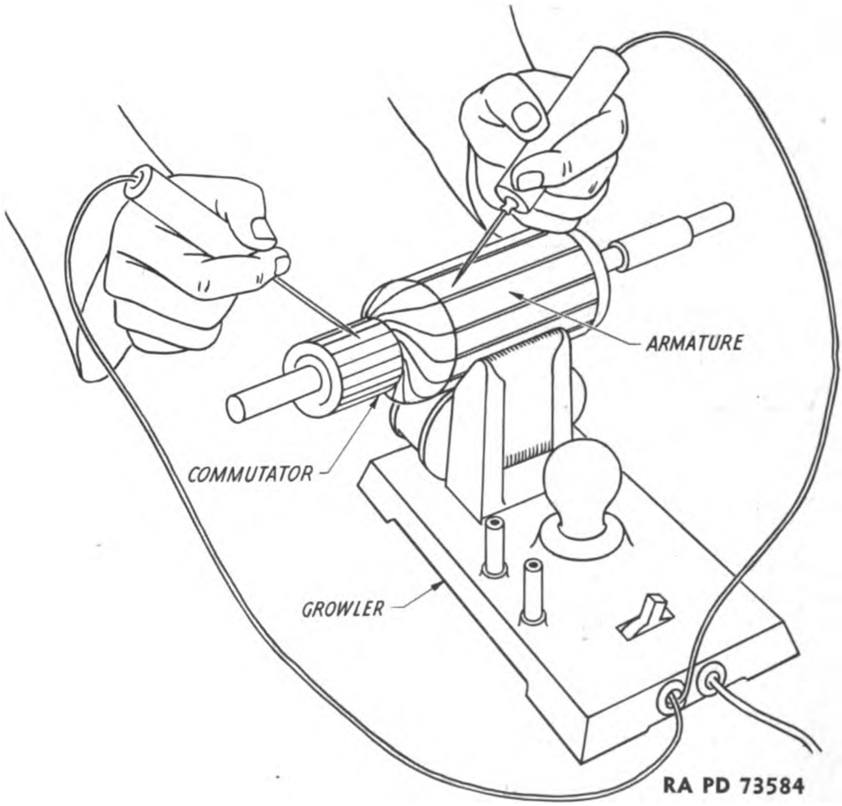

Figure 135 — Testing Commutator Bars

(c) Check the commutator for roughness, and if rough, turn it down on a lathe until it is thoroughly clean, after which dress with PAPER, flint, class B, No. 2/0. Undercut the mica (fig. 137), and again check armature on growler for shorts.

(d) Check armature to commutator leads. See that they are properly soldered to commutator.

(3) GENERAL TESTS.

(a) Check fit of armature shaft in commutator end bearing. If bearing is worn, replace it.

(b) Clean ball bearings in SOLVENT, dry-cleaning, and blow out with compressed air. Check bearings for wear or roughness. Replace if necessary.

(c) Check to see that brush springs have enough tension to hold brushes snugly against the commutator. Replace if necessary.

(d) Check brushes for wear and condition. Replace if worn to half their original length, or if broken.

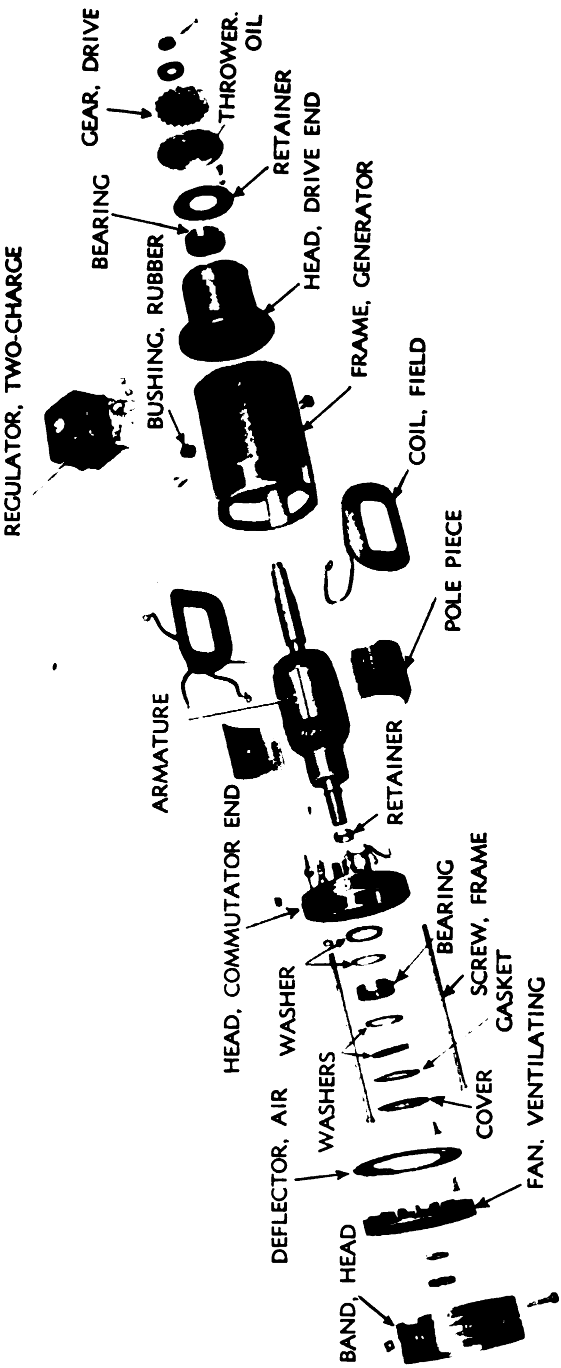

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Figure 134 — Generator — Exploded View

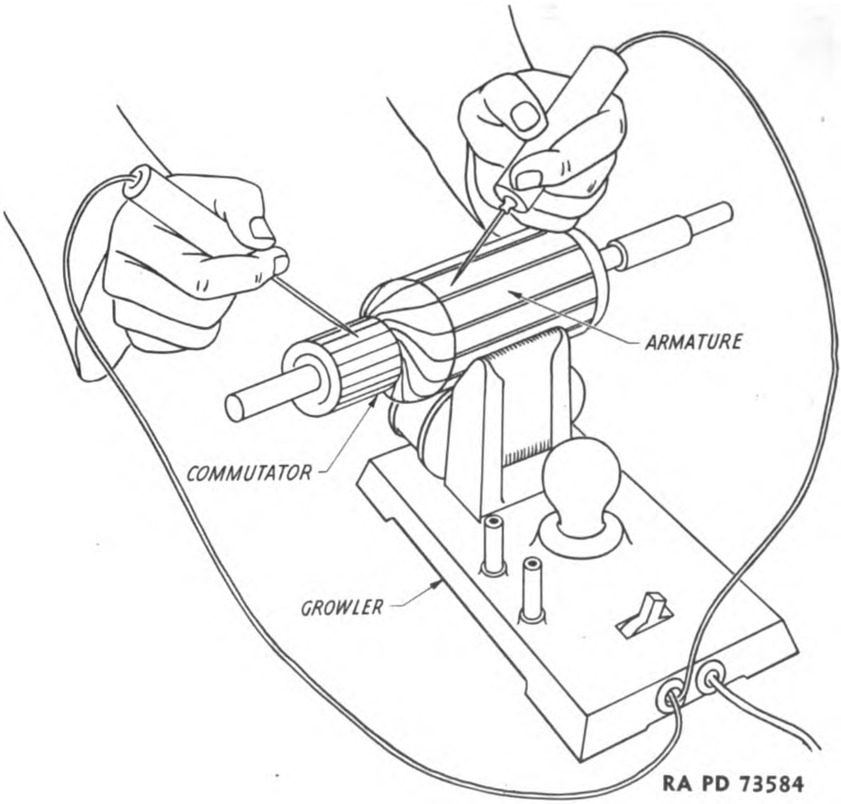

Figure 135 — Testing Commutator Bars

(c) Check the commutator for roughness, and if rough, turn it down on a lathe until it is thoroughly clean, after which dress with PAPER, flint, class B, No. 2/0. Undercut the mica (fig. 137), and again check armature on growler for shorts.

(d) Check armature to commutator leads. See that they are properly soldered to commutator.

(3) GENERAL TESTS.

(a) Check fit of armature shaft in commutator end bearing. If bearing is worn, replace it.

(b) Clean ball bearings in SOLVENT, dry-cleaning, and blow out with compressed air. Check bearings for wear or roughness. Replace if necessary.

(c) Check to see that brush springs have enough tension to hold brushes snugly against the commutator. Replace if necessary.

(d) Check brushes for wear and condition. Replace if worn to half their original length, or if broken.

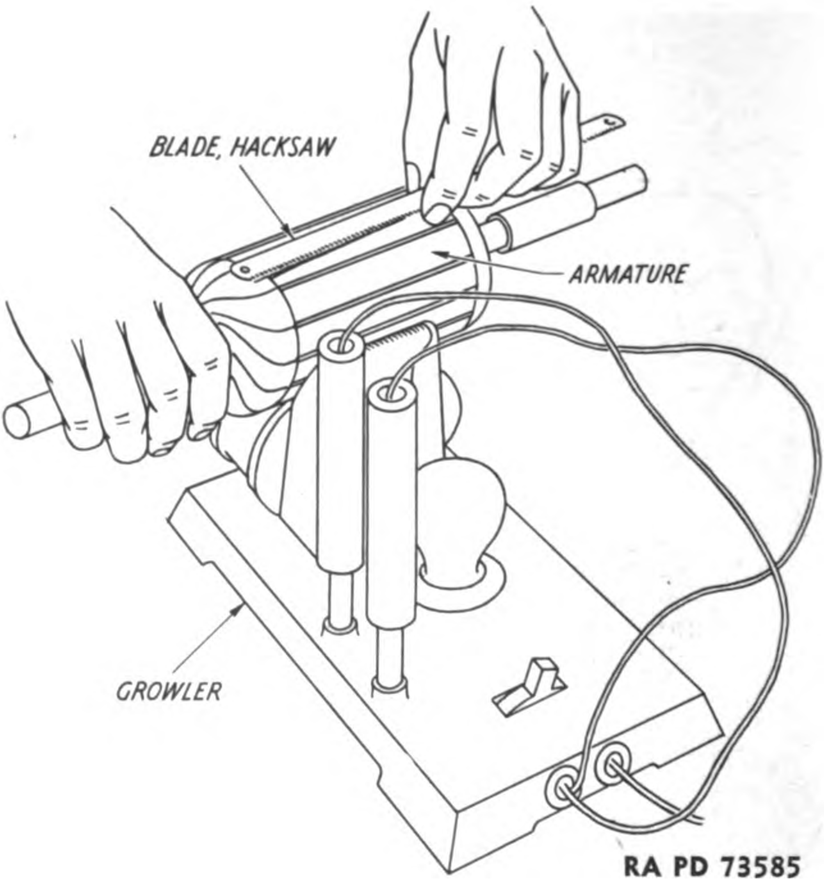

Figure 136 – Testing Armature for Shorts

65. GENERATOR ASSEMBLY (fig. 134).

a. Procedure.

(1) Press drive end head bearing on armature shaft, and press armature shaft into position in drive end head.

(2) Connect the field coils by soldering together the lead from each coil not attached to a lug. Attach the field coils to the frame by inserting a pole piece through each coil, and securing pole pieces and coils to the frame with flat-head screws. Bring the single unused wire from the one field coil up through the housing bushing hole. Carry one of the ends of the gray wire taped to the other field coil out through the same hole, and install the rubber bushing.

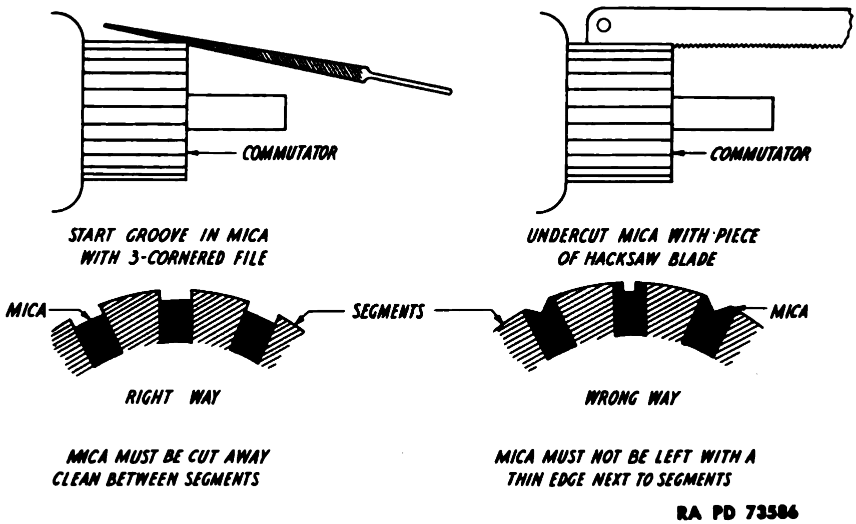

Figure 137 — Undercutting Commutators Mica

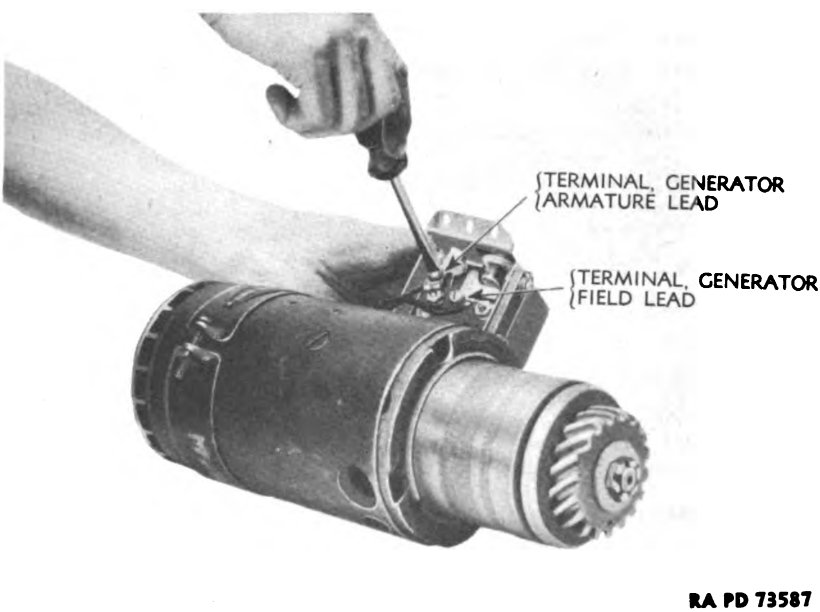

Figure 138 — Removing Regulator from Generator — Taking Off Armature Connection

(3) Attach third brush-holding ring and ring yoke to head with screw through yoke. Install brush-holder springs and spring clips on commutator head posts. Hold back clips, and set brushes in place.

(4) Carry commutator end head over the commutator end of the armature and attach commutator end head, frame, and drive end head with the frame screws.

(5) To the brush holder that has no insulation between it and the ring, secure only the brush pigtail connection with screw. To the third, or adjustable brush holder, connect the brush connector and the black field lead with screw. To the remaining brush holder, attach its brush connection and the gray wire, which is the armature lead.

(6) Slide retainer into position on armature shaft. Install the felt and metal washers, and press the bearing into place in commutator end head.

(7) Slide metal and felt washers over armature shaft then the gasket and cover, and attach cover with screws. Install cover with flat-head screws. Install Woodruff key in shaft. Place air deflector and fan in position, and secure with nut.

(8) Place retainer in position over shaft at drive end, and secure to head with flat-head screws. Insert Woodruff key in shaft and slide oil thrower onto shaft. Press drive gear into position, install washer and castellated nut, and secure with cotter pin.

(9) To pole marked "A" (for armature), on bottom of regulator, connect the gray generator wire with screws. To pole "F" (for field), connect the black lead with screw. Secure regulator base to generator frame with round-head machine screws.

66. GENERATOR REGULATOR.

a. **Description and Operation** (par. 61 c).

b. **Removal** (par. 63 a (1)) (fig. 138).

c. **Disassembly.**

(1) Remove cover nut, and lift cover from regulator.

(2) Remove carbon resistor screws, and lift off carbon resistor (fig. 139).

(3) Unscrew fuse cap and remove fuse, fuse insulation, and fuse from regulator body.

d. **Inspection and Repair.**

(1) Examine for evidence of burning or abnormally high temperatures at the coils, contacts, insulation, external terminals, or other points.

(2) Examine for loose connections resulting from poor soldering.

(3) Examine for loose nuts on bottom of magnet cores, loose rivets, or screws. All nuts and screws must have lock washers.

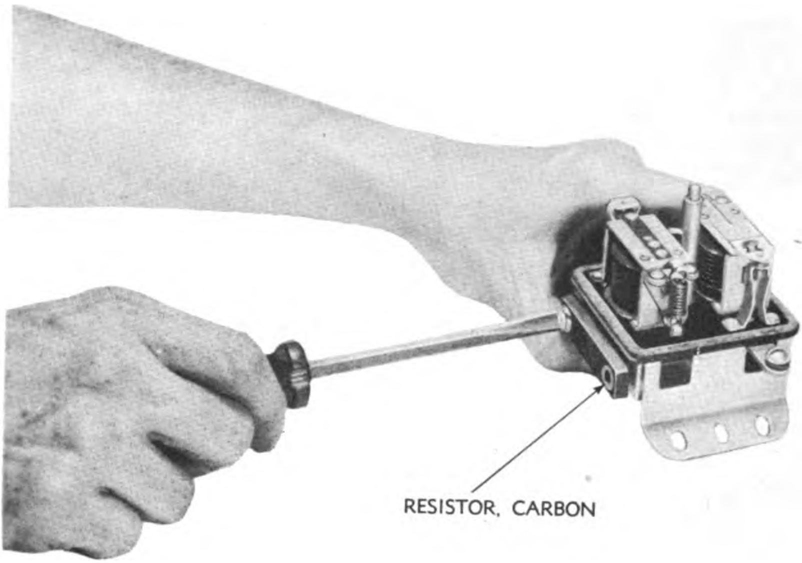

Figure 139 — Removing Carbon Resistor from Regulator

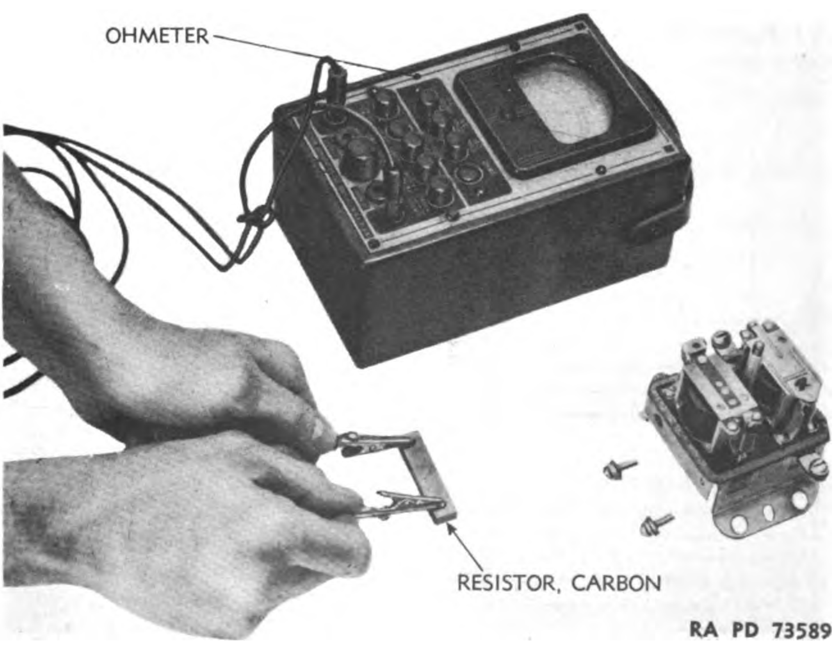

Figure 140 — Testing Carbon Resistor with Ohmmeter

(3) Attach third brush-holding ring and ring yoke to head with screw through yoke. Install brush-holder springs and spring clips on commutator head posts. Hold back clips, and set brushes in place.

(4) Carry commutator end head over the commutator end of the armature and attach commutator end head, frame, and drive end head with the frame screws.

(5) To the brush holder that has no insulation between it and the ring, secure only the brush pigtail connection with screw. To the third, or adjustable brush holder, connect the brush connector and the black field lead with screw. To the remaining brush holder, attach its brush connection and the gray wire, which is the armature lead.

(6) Slide retainer into position on armature shaft. Install the felt and metal washers, and press the bearing into place in commutator end head.

(7) Slide metal and felt washers over armature shaft then the gasket and cover, and attach cover with screws. Install cover with flat-head screws. Install Woodruff key in shaft. Place air deflector and fan in position, and secure with nut.

(8) Place retainer in position over shaft at drive end, and secure to head with flat-head screws. Insert Woodruff key in shaft and slide oil thrower onto shaft. Press drive gear into position, install washer and castellated nut, and secure with cotter pin.

(9) To pole marked "A" (for armature), on bottom of regulator, connect the gray generator wire with screws. To pole "F" (for field), connect the black lead with screw. Secure regulator base to generator frame with round-head machine screws.

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c. Disassembly.

(1) Remove cover nut, and lift cover from regulator.

(2) Remove carbon resistor screws, and lift off carbon resistor (fig. 139).

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ENGINE AND ACCESSORIES

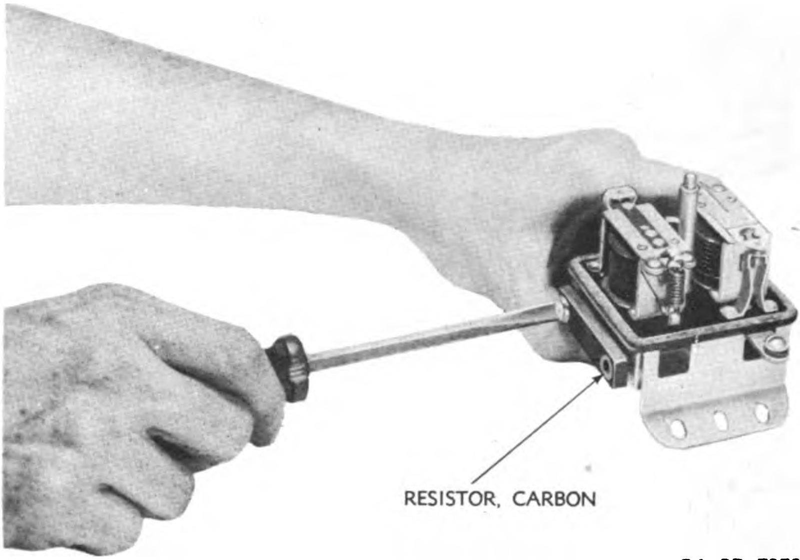

Figure 139 — Removing Carbon Resistor from Regulator

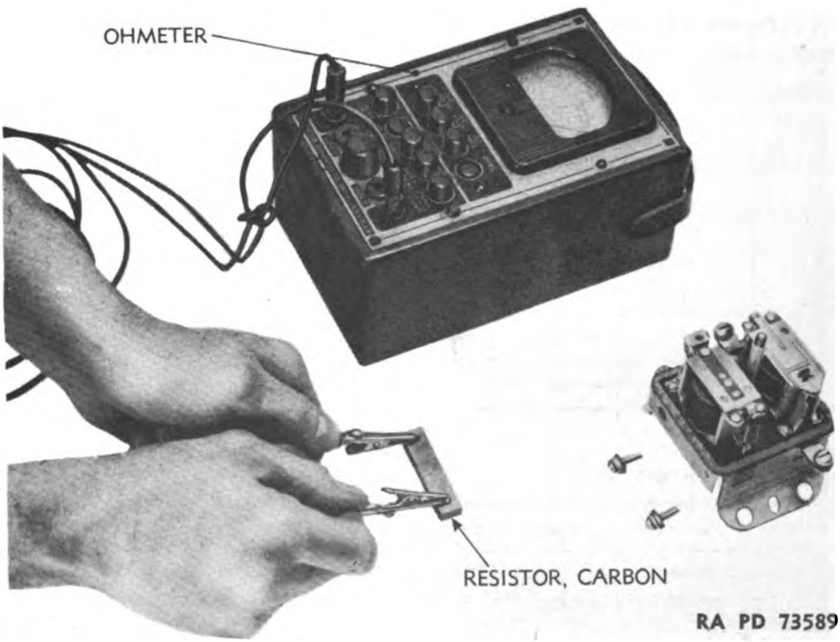

Figure 140 — Testing Carbon Resistor with Ohmmeter

(3) Attach third brush-holding ring and ring yoke to head with screw through yoke. Install brush-holder springs and spring clips on commutator head posts. Hold back clips, and set brushes in place.

(4) Carry commutator end head over the commutator end of the armature and attach commutator end head, frame, and drive end head with the frame screws.

(5) To the brush holder that has no insulation between it and the ring, secure only the brush pigtail connection with screw. To the third, or adjustable brush holder, connect the brush connector and the black field lead with screw. To the remaining brush holder, attach its brush connection and the gray wire, which is the armature lead.

(6) Slide retainer into position on armature shaft. Install the felt and metal washers, and press the bearing into place in commutator end head.

(7) Slide metal and felt washers over armature shaft then the gasket and cover, and attach cover with screws. Install cover with flat-head screws. Install Woodruff key in shaft. Place air deflector and fan in position, and secure with nut.

(8) Place retainer in position over shaft at drive end, and secure to head with flat-head screws. Insert Woodruff key in shaft and slide oil thrower onto shaft. Press drive gear into position, install washer and castellated nut, and secure with cotter pin.

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(2) Examine for loose connections resulting from poor soldering.

(3) Examine for loose nuts on bottom of magnet cores, loose rivets, or screws. All nuts and screws must have lock washers.

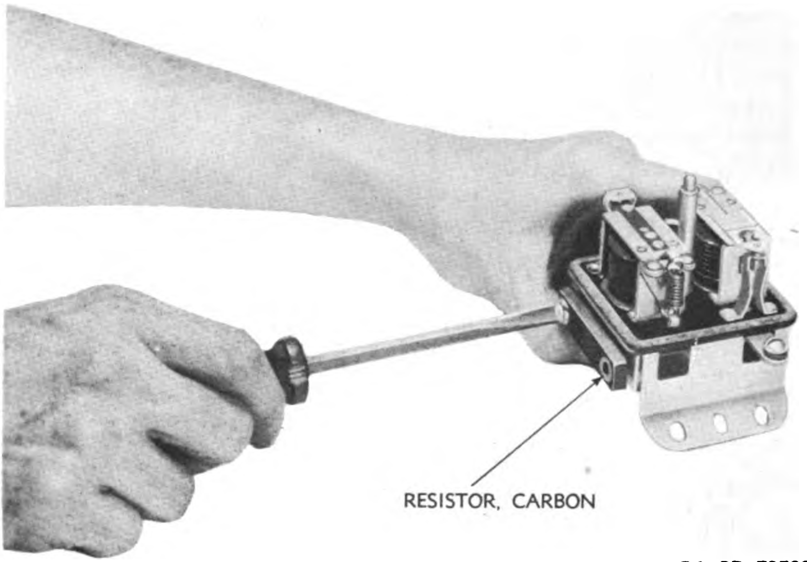


Figure 139 — Removing Carbon Resistor from Regulator

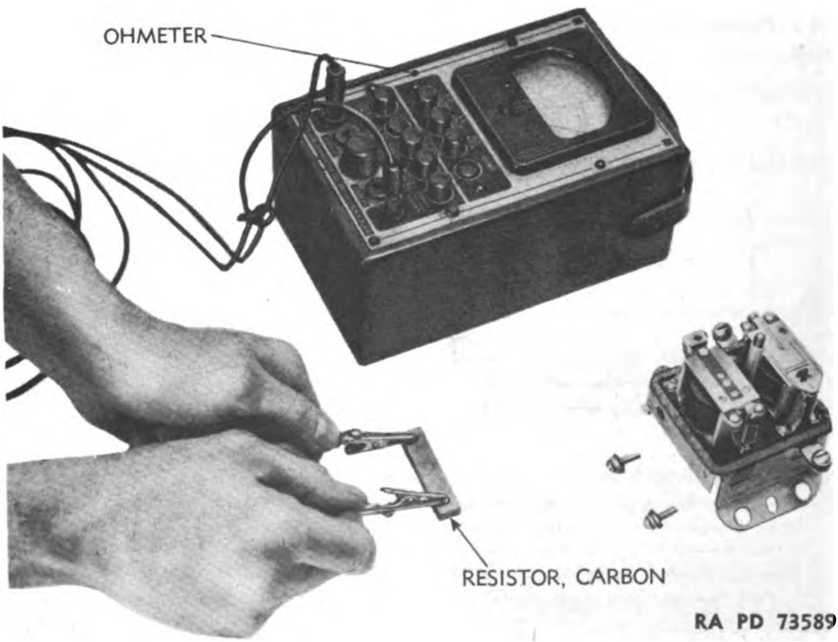


Figure 140 — Testing Carbon Resistor with Ohmmeter

(3) Attach third brush-holding ring and ring yoke to head with screw through yoke. Install brush-holder springs and spring clips on commutator head posts. Hold back clips, and set brushes in place.

(4) Carry commutator end head over the commutator end of the armature and attach commutator end head, frame, and drive end head with the frame screws.

(5) To the brush holder that has no insulation between it and the ring, secure only the brush pigtail connection with screw. To the third, or adjustable brush holder, connect the brush connector and the black field lead with screw. To the remaining brush holder, attach its brush connection and the gray wire, which is the armature lead.

(6) Slide retainer into position on armature shaft. Install the felt and metal washers, and press the bearing into place in commutator end head.

(7) Slide metal and felt washers over armature shaft then the gasket and cover, and attach cover with screws. Install cover with flat-head screws. Install Woodruff key in shaft. Place air deflector and fan in position, and secure with nut.

(8) Place retainer in position over shaft at drive end, and secure to head with flat-head screws. Insert Woodruff key in shaft and slide oil thrower onto shaft. Press drive gear into position, install washer and castellated nut, and secure with cotter pin.

(9) To pole marked "A" (for armature), on bottom of regulator, connect the gray generator wire with screws. To pole "F" (for field), connect the black lead with screw. Secure regulator base to generator frame with round-head machine screws.

66. GENERATOR REGULATOR.

a. Description and Operation (par. 61 c).

b. Removal (par. 63 a (1)) (fig. 138).

c. Disassembly.

(1) Remove cover nut, and lift cover from regulator.

(2) Remove carbon resistor screws, and lift off carbon resistor (fig. 139).

(3) Unscrew fuse cap and remove fuse, fuse insulation, and fuse from regulator body.

d. Inspection and Repair.

(1) Examine for evidence of burning or abnormally high temperatures at the coils, contacts, insulation, external terminals, or other points.

(2) Examine for loose connections resulting from poor soldering.

(3) Examine for loose nuts on bottom of magnet cores, loose rivets, or screws. All nuts and screws must have lock washers.

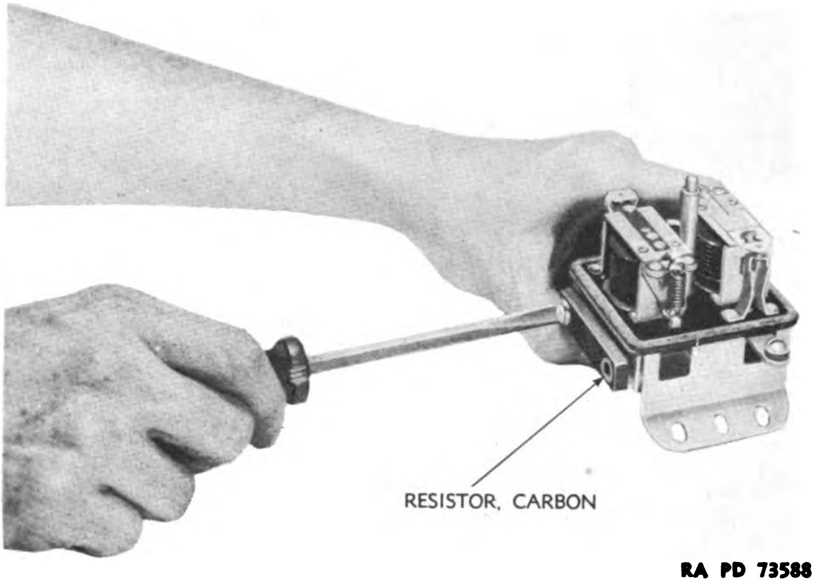


Figure 139 — Removing Carbon Resistor from Regulator

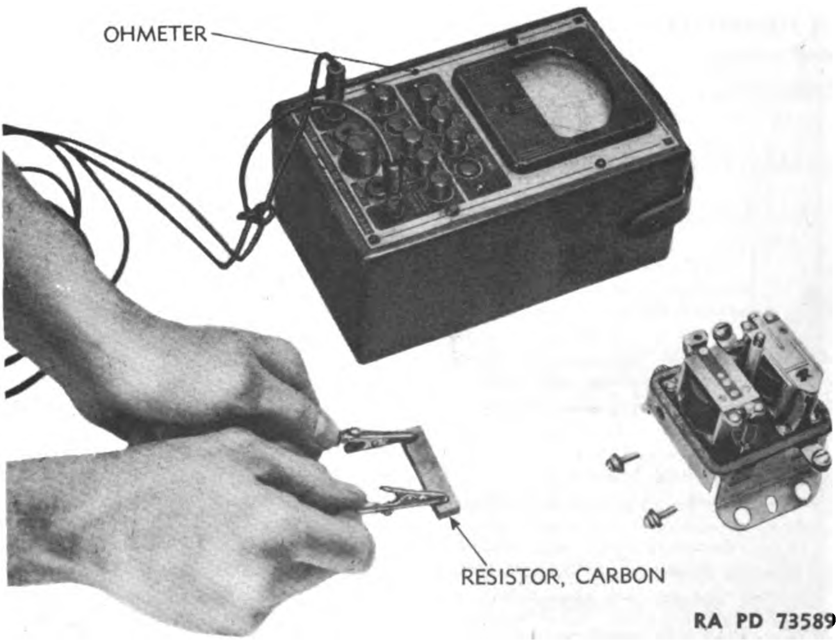


Figure 140 — Testing Carbon Resistor with Ohmmeter

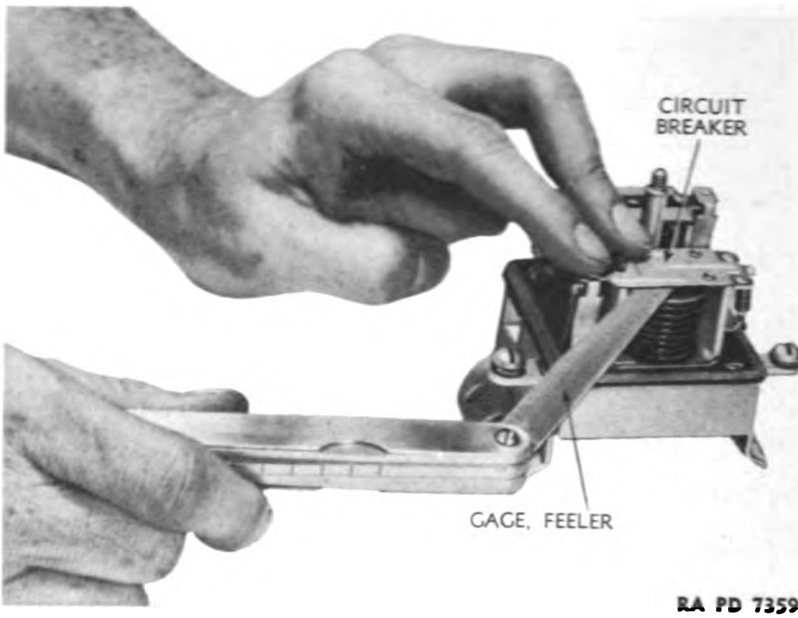


Figure 141 – Checking Circuit Breaker Armature Air Gap

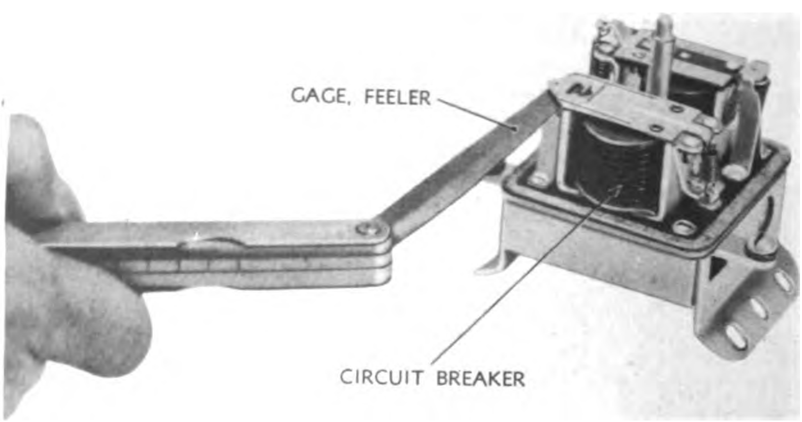


Figure 142 – Checking Circuit Breaker Contact Gap

(4) CONTACTS. Clean all contacts by filing, parallel with length of the armature, with a very fine file (ST-290) so that they are free from pits and burning. Clean points with CARBON TETRACHLORIDE to remove any dirt or grease. Pull a piece of clean linen tape between contacts to remove any residue.

(5) CARBON RESISTOR. Check resistance of the carbon resistor with an ohmmeter (fig. 140). It must read 7 ohms, plus or minus 5 percent. Replace if necessary.

(6) CIRCUIT BREAKER ARMATURE AIR GAP. Check circuit breaker armature gap (fig. 141). This check is made with contacts closed, and is adjusted by raising or lowering stationary contact. Adjust to 0.010 to 0.030 inch.

(7) CIRCUIT BREAKER CONTACT GAP. Check circuit breaker contact gap (fig. 142). It must be 0.015 to 0.045 inch. Adjust by bending armature stop.

(8) REGULATOR ARMATURE AIR GAP (fig. 143). Check regulator armature air gap. It must be 0.044 to 0.046 inch. Measure gap with regulator contact closed. Adjust by raising or lowering upper contact by expanding or contracting the bridge holding upper contact.

(9) Check regulator contact gap (fig. 144). It must have 0.005-inch minimum gap. Adjust by turning brass cam.

e. Assembly.

(1) Assemble fuse, fuse insulation, and fuse cap to regulator body.

(2) Assemble carbon resistor, carbon resistor screw insulating washers, and two screws to regulator body.

(3) Place gasket on regulator body, and assemble cover and cover nut to regulator body.

f. Battery-charging Generator Regulator Tests.

(1) CHECK CIRCUIT BRAKER OPERATION.

(a) Connect the circuit breaker, a voltmeter, potentiometer, a 12-volt battery, and a lamp in series, as illustrated per diagram in figure 145.

(b) Increase voltage from zero, and note voltage at which contact points close, as indicated by the lamp lighting.

(c) Voltage must be 6.5 to 7.25 volts. Adjust circuit breaker gap until voltmeter reading is within these limits (subpar. d (7), above).

(2) CHECK REGULATOR OPERATION.

(a) Connect the regulator, voltmeter, potentiometer, a 12-volt battery, and lamp in series as illustrated per diagram in figure 145.

(b) Increase voltage from zero, and note voltage at which contacts open as indicated by lamp dimming or going out.

(3) Attach third brush-holding ring and ring yoke to head with screw through yoke. Install brush-holder springs and spring clips on commutator head posts. Hold back clips, and set brushes in place.

(4) Carry commutator end head over the commutator end of the armature and attach commutator end head, frame, and drive end head with the frame screws.

(5) To the brush holder that has no insulation between it and the ring, secure only the brush pigtail connection with screw. To the third, or adjustable brush holder, connect the brush connector and the black field lead with screw. To the remaining brush holder, attach its brush connection and the gray wire, which is the armature lead.

(6) Slide retainer into position on armature shaft. Install the felt and metal washers, and press the bearing into place in commutator end head.

(7) Slide metal and felt washers over armature shaft then the gasket and cover, and attach cover with screws. Install cover with flat-head screws. Install Woodruff key in shaft. Place air deflector and fan in position, and secure with nut.

(8) Place retainer in position over shaft at drive end, and secure to head with flat-head screws. Insert Woodruff key in shaft and slide oil thrower onto shaft. Press drive gear into position, install washer and castellated nut, and secure with cotter pin.

(9) To pole marked "A" (for armature), on bottom of regulator, connect the gray generator wire with screws. To pole "F" (for field), connect the black lead with screw. Secure regulator base to generator frame with round-head machine screws.

66. GENERATOR REGULATOR.

a. Description and Operation (par. 61 c).

b. Removal (par. 63 a (1)) (fig. 138).

c. Disassembly.

(1) Remove cover nut, and lift cover from regulator.

(2) Remove carbon resistor screws, and lift off carbon resistor (fig. 139).

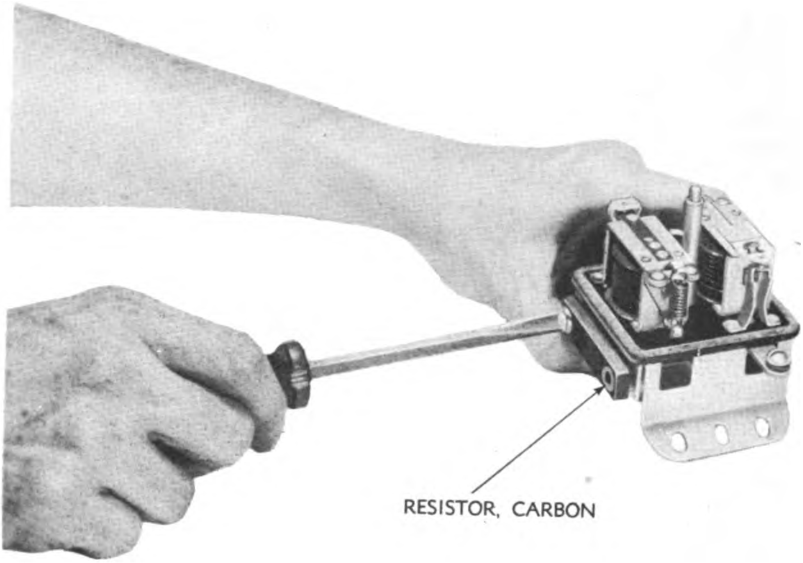
(3) Unscrew fuse cap and remove fuse, fuse insulation, and fuse from regulator body.

d. Inspection and Repair.

(1) Examine for evidence of burning or abnormally high temperatures at the coils, contacts, insulation, external terminals, or other points.

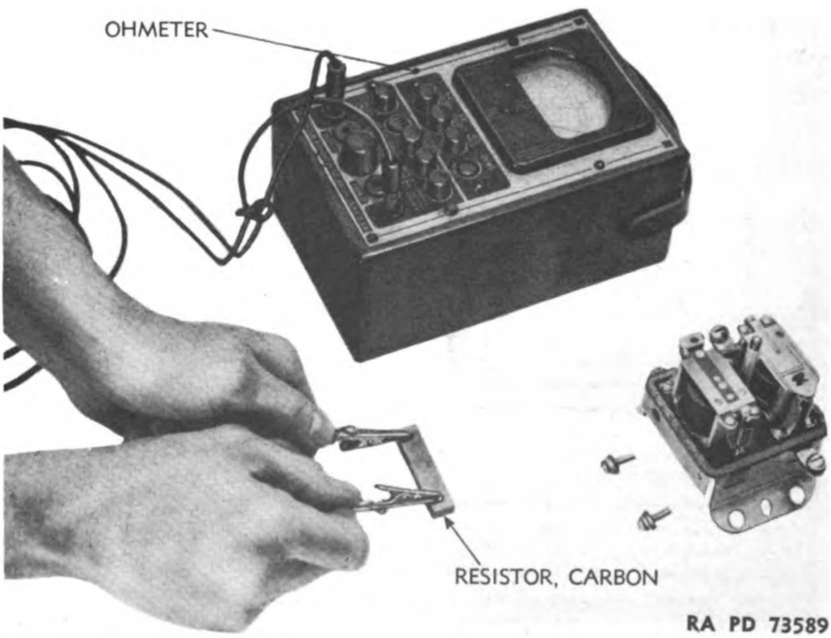
(2) Examine for loose connections resulting from poor soldering.

(3) Examine for loose nuts on bottom of magnet cores, loose rivets, or screws. All nuts and screws must have lock washers.



RA PD 73588

Figure 139 — Removing Carbon Resistor from Regulator



RA PD 73589

Figure 140 — Testing Carbon Resistor with Ohmmeter

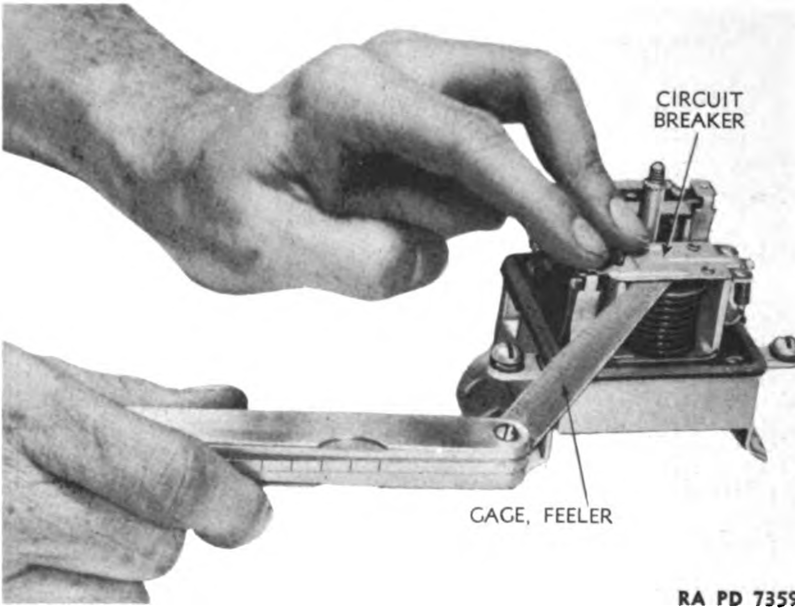
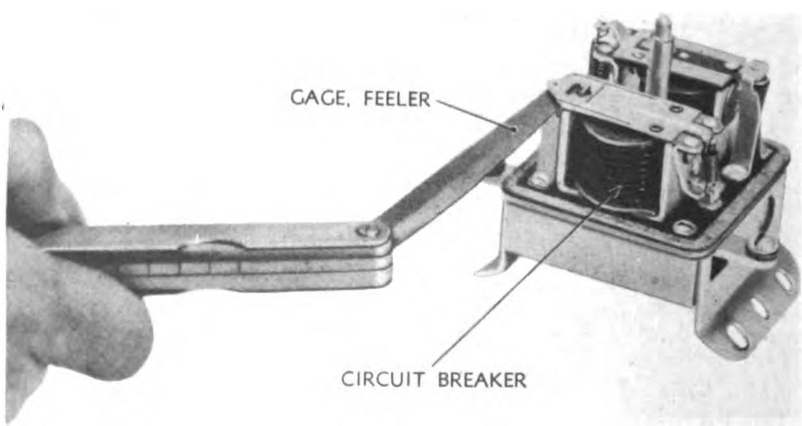


Figure 141 — Checking Circuit Breaker Armature Air Gap



RA PD 73591

Figure 142 — Checking Circuit Breaker Contact Gap

(4) CONTACTS. Clean all contacts by filing, parallel with length of the armature, with a very fine file (ST-290) so that they are free from pits and burning. Clean points with CARBON TETRACHLORIDE to remove any dirt or grease. Pull a piece of clean linen tape between contacts to remove any residue.

(5) CARBON RESISTOR. Check resistance of the carbon resistor with an ohmmeter (fig. 140). It must read 7 ohms, plus or minus 5 percent. Replace if necessary.

(6) CIRCUIT BREAKER ARMATURE AIR GAP. Check circuit breaker armature gap (fig. 141). This check is made with contacts closed, and is adjusted by raising or lowering stationary contact. Adjust to 0.010 to 0.030 inch.

(7) CIRCUIT BREAKER CONTACT GAP. Check circuit breaker contact gap (fig. 142). It must be 0.015 to 0.045 inch. Adjust by bending armature stop.

(8) REGULATOR ARMATURE AIR GAP (fig. 143). Check regulator armature air gap. It must be 0.044 to 0.046 inch. Measure gap with regulator contact closed. Adjust by raising or lowering upper contact by expanding or contracting the bridge holding upper contact.

(9) Check regulator contact gap (fig. 144). It must have 0.005-inch minimum gap. Adjust by turning brass cam.

e. Assembly.

(1) Assemble fuse, fuse insulation, and fuse cap to regulator body.

(2) Assemble carbon resistor, carbon resistor screw insulating washers, and two screws to regulator body.

(3) Place gasket on regulator body, and assemble cover and cover nut to regulator body.

f. Battery-charging Generator Regulator Tests.

(1) CHECK CIRCUIT BRAKER OPERATION.

(a) Connect the circuit breaker, a voltmeter, potentiometer, a 12-volt battery, and a lamp in series, as illustrated per diagram in figure 145.

(b) Increase voltage from zero, and note voltage at which contact points close, as indicated by the lamp lighting.

(c) Voltage must be 6.5 to 7.25 volts. Adjust circuit breaker gap until voltmeter reading is within these limits (subpar. d (7), above).

(2) CHECK REGULATOR OPERATION.

(a) Connect the regulator, voltmeter, potentiometer, a 12-volt battery, and lamp in series as illustrated per diagram in figure 145.

(b) Increase voltage from zero, and note voltage at which contacts open as indicated by lamp dimming or going out.

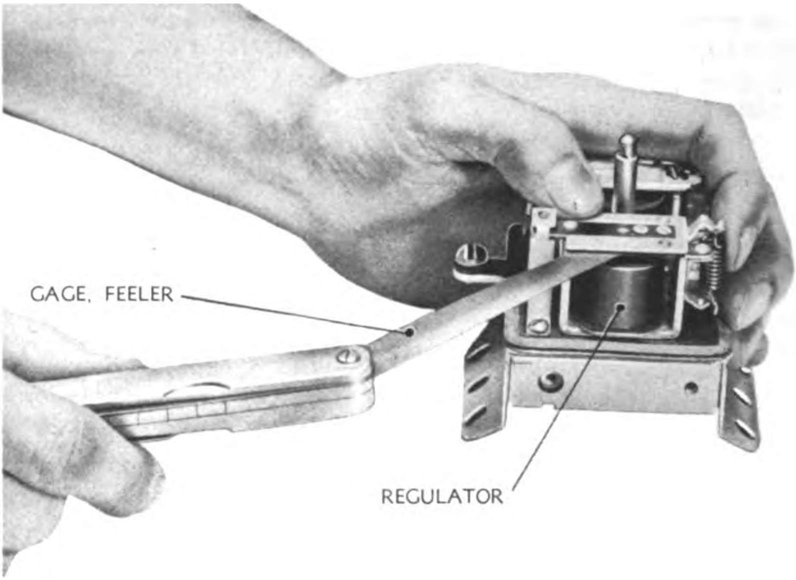


Figure 143 — Checking Regulator Armature Air Gap

(c) This voltage figure must be within the specifications, and at temperature shown in the following scale:

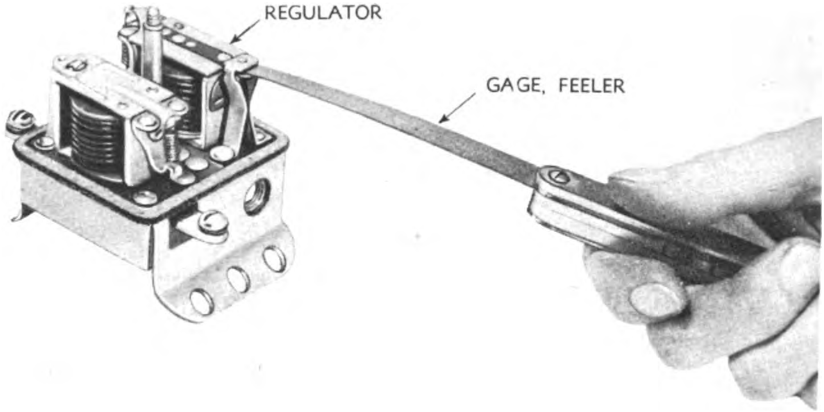
TEMPERATURE	VOLTAGE		
Degrees Fahrenheit	High	Low	Ideal
50	8.90	8.40	8.65
60	8.82	8.32	8.57
70	8.75	8.25	8.50
80	8.68	8.18	8.43
90	8.60	8.10	8.35
100	8.53	8.03	8.28
110	8.46	7.96	8.21

(d) Adjust the regulator contact gap by bending spring hanger until readings fall within above scale (step d, (8) above).

(e) Reduce voltage and check contact closing voltage as indicated by lamp lighting. This voltage reading must be from 1.2 to 2.4 volts below the contact opening voltage. Adjust gap by turning brass cam.

g. Installation.

(1) Attach generator field lead (black wire) to terminal marked "F" on bottom of regulator.



RA PD 73593

Figure 144 – Checking Regulator Contact Gap

(2) Attach generator armature lead (gray wire) to terminal marked "A" on bottom of regulator.

(3) Place regulator in position on generator.

(4) Install the four mounting screws and lock washers.

(5) Attach wire from "CG" post on terminal block to terminal marked "B" on engine side of battery regulator.

67. BATTERY DESCRIPTION.

a. The battery is a lead-acid, 3-cell, 6-volt model, with each cell containing 17 plates and delivering 2 volts. It has a capacity of 160 ampere-hours, when discharged at a 20-hour rate.

b. The container is made of rubber with the cells formed by partitions dividing the interior. The cells are closed by hard rubber covers sealed in place, with holes to provide for the cell terminals and a vent. Each negative group of plates, two of which are end plates, are permanently connected at the top to a metal strap carrying the projecting negative terminal. The positive plates, arranged alternately with the negative plates, are similarly connected in a group by a strap carrying the projecting positive terminals. Separators are placed between the adjacent positive and negative plates. The plates and separators rest on ribs molded in the bottom of the container. The exposed terminal posts of adjacent cells are joined, positive to negative, by outside connectors burned to the terminal posts on the tops of the cells, and connect the cells in series. Screw type vent plugs, which have small openings for the escape of gas, fit the openings in the center of each cell, and permit inspection of the inside of the cells and replenishment of the electrolyte or water. Circular rubber gaskets fit around the terminal posts in the covers and make the terminals leakproof.

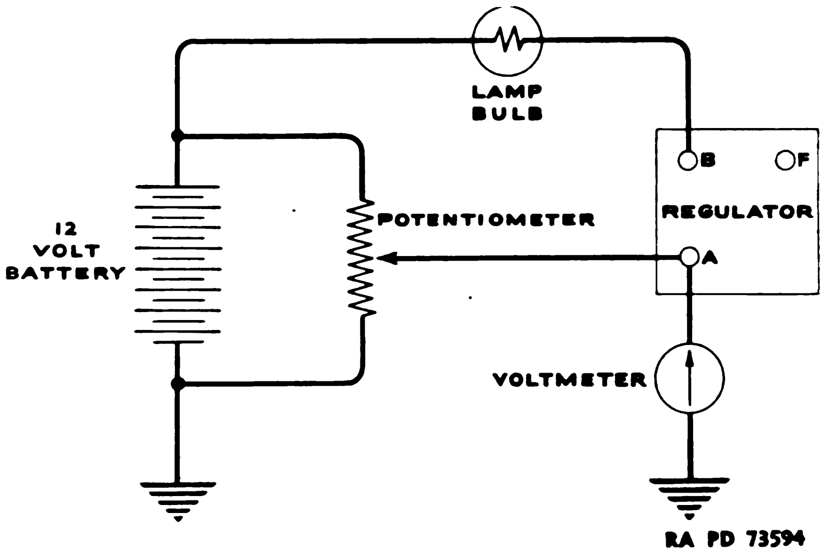


Figure 145 – Circuit Diagram for Testing Circuit Breaker Operation

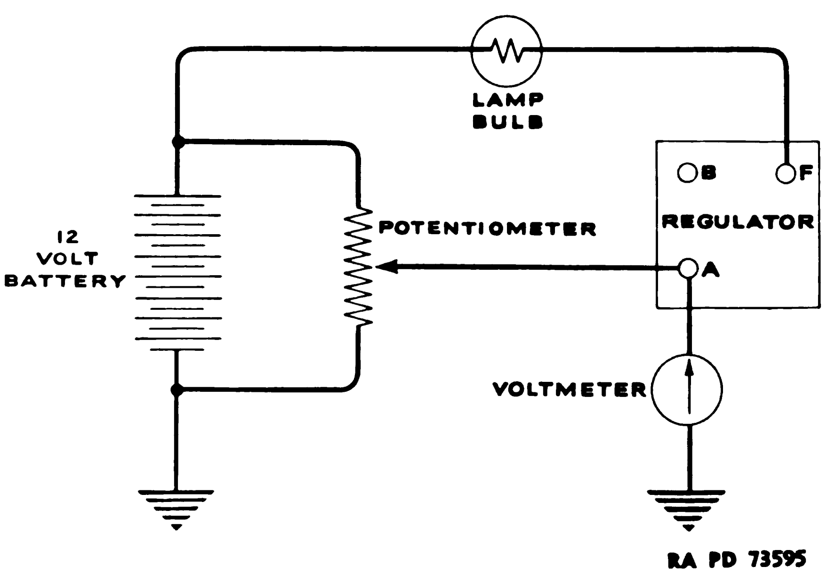


Figure 146 – Circuit Diagram for Testing Regulator Operation

c. The active materials in the lead-acid storage battery are as follows: The positive plate contains lead peroxide (chocolate brown color); the negative plate contains metallic lead in a finely divided

form, called sponge lead; the electrolyte is a solution of sulphur acid in water. During discharge, the active material in both the positive and negative plates reacts with the sulphuric acid of the electrolyte and is converted to lead sulphate. This action removes acid from the electrolyte and thus lowers its specific gravity. Both plates become converted in part to the same substance, lead sulphate, and the voltage delivered by the cell is reduced. The reverse action takes place when the cell is being charged. Acid is restored to the electrolyte, which increases the specific gravity of the electrolyte, and the plates are reconverted to the original materials. During both discharging and charging cycles, some of the water in the electrolyte decomposes into its elements, hydrogen and oxygen, which escape as gases from the solution. The quantity of gas released is much greater during charging than during discharging. These gases are explosive.

68. BATTERY MAINTENANCE.

a. **Inspection.** At least once a week, inspect the electrolyte level and terminals, and see that the battery is well secured. The electrolyte level should be kept ⅜ inch above the separators. If the electrolyte appears too low in any cell, look for a leak in the container or sealing. The open-circuit voltage of a fully charged cell is approximately 2.12 volts. The terminal voltage of a discharged cell is 1.75 volts, when discharging at the normal rate. After discharging, the open-circuit voltage will rise to about 1.98 volts per cell. Actual values will vary with temperature.

b. **Electrolyte.**

(1) To maintain the level of the electrolyte, add distilled water. Boiling, filtering, and the use of "softening" materials or devices will not remove impurities from water that may injure the battery. Wipe top of battery and terminals dry after filling.

(2) Remove vent plugs, and test each cell with an accurate hydrometer. The reading for a fully-charged cell should be between 1.275 and 1.300. If any cells are below 1.225, place the battery on charge.

(3) Acid should never be added to the battery except to replace acid which has leaked out, been spilled, or been lost by overflushing. Adding acid to raise the specific gravity will not increase the state of charge. It will render hydrometer readings of no value, and shorten the life of the battery. When acid has been lost, add water and bring battery to a fully-charged state as indicated by no rise in the specific gravity of the electrolyte between successive readings during charge. Then empty the battery, and put in new electrolyte of 1.280 specific gravity. Continue charging at the normal rate, and after 1 hour, read the specific gravity. If it is below normal, withdraw some of the electrolyte and

replace with new electrolyte. If the specific gravity of the electrolyte is too high, remove electrolyte and replace with water. Continue charging, read the specific gravity, and repeat the adjustment at hourly intervals until the normal specific gravity is obtained. The battery must be charging and gassing during the entire adjustment procedure.

c. **Charging.**

(1) The charging rate of a battery depends upon the capacity of the battery and the charging method used. Continue charging until the battery is fully charged, as indicated by no rise in specific gravity in successive hydrometer readings. Take readings of specific gravity and voltage for each cell every hour. These readings should be recorded so as to eliminate under charging or over charging. The charging rate should not be too high, as evidenced by excessive gassing or temperature rise. The temperature of the battery should not be permitted to rise above 110 F (125 F in tropics). Mild gassing from a battery toward the end of charge is normal. Violent gassing or bubbling indicates excessive charging rates. After gassing starts, the charging rate should be approximately 1.0 ampere per positive plate (one cell). When placing a battery on charge, add distilled water to raise the electrolyte to the proper level (3/8 inch above separators), then replace the vent plugs.

CAUTION: The gas given off by storage batteries is a mixture of hydrogen and oxygen, and is highly explosive. Keep flames or sparks away from batteries on charge or discharge.

(2) CONSTANT-CURRENT CHARGING. A relatively high voltage d-c power source can be used for battery charging, if sufficient resistance is added to the circuit to limit the charging rate (current) to a safe value. The rise in battery voltage during charge is small compared to the voltage drop across the resistance, and the current remains practically constant throughout the charging period. When charging a number of batteries, several may be connected in series. The maximum number of cells that may be charged from a power source is the number obtained by dividing the voltage of the power source by 2.6. In series charging, the batteries must be carefully watched, and as each battery becomes fully charged it must be removed from the circuit.

(3) CONSTANT-VOLTAGE CHARGING. The time required for charging can be reduced by the use of a tapering current. If the power supply has a constant voltage of 2.50 volts per cell, this is accomplished automatically. The initial charging current drops rapidly as the battery charges. Be careful that the initial charging rate is not too high, as evidenced by excessive gassing, otherwise little attention is required for batteries on taper charge.

(4) TRICKLE CHARGING. Trickle charging is the continual application of a very low charging current. This method of maintaining the charge of batteries is not recommended for automotive type batteries.

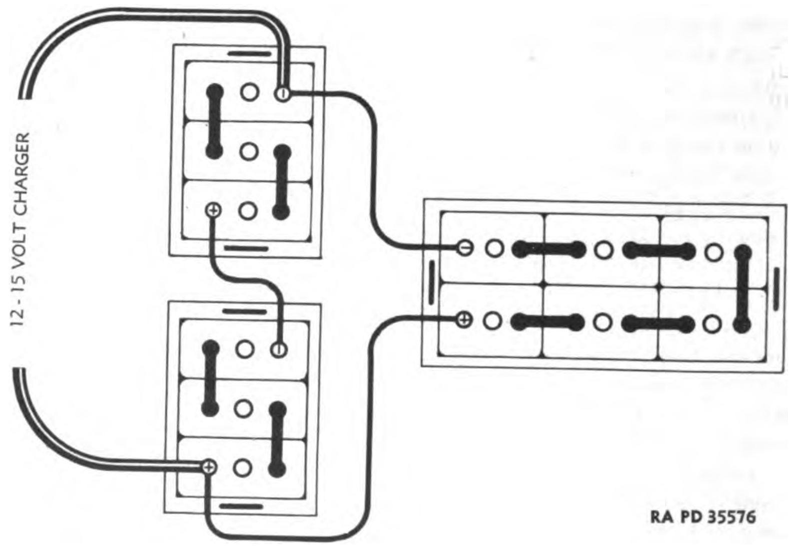


Figure 147 — Charging Two 6-volt Batteries and One 12-volt Battery in Parallel

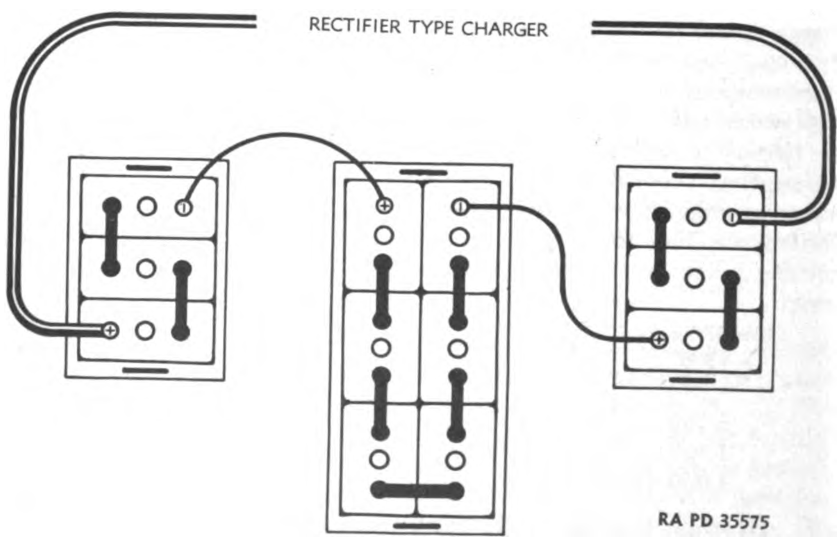


Figure 148 — Charging Two 6-volt Batteries and One 12-volt Battery in Series

replace with new electrolyte. If the specific gravity of the electrolyte is too high, remove electrolyte and replace with water. Continue charging, read the specific gravity, and repeat the adjustment at hourly intervals until the normal specific gravity is obtained. The battery must be charging and gassing during the entire adjustment procedure.

c. **Charging.**

(1) The charging rate of a battery depends upon the capacity of the battery and the charging method used. Continue charging until the battery is fully charged, as indicated by no rise in specific gravity in successive hydrometer readings. Take readings of specific gravity and voltage for each cell every hour. These readings should be recorded so as to eliminate under charging or over charging. The charging rate should not be too high, as evidenced by excessive gassing or temperature rise. The temperature of the battery should not be permitted to rise above 110 F (125 F in tropics). Mild gassing from a battery toward the end of charge is normal. Violent gassing or bubbling indicates excessive charging rates. After gassing starts, the charging rate should be approximately 1.0 ampere per positive plate (one cell). When placing a battery on charge, add distilled water to raise the electrolyte to the proper level (3/8 inch above separators), then replace the vent plugs.

CAUTION: The gas given off by storage batteries is a mixture of hydrogen and oxygen, and is highly explosive. Keep flames or sparks away from batteries on charge or discharge.

(2) CONSTANT-CURRENT CHARGING. A relatively high voltage d-c power source can be used for battery charging, if sufficient resistance is added to the circuit to limit the charging rate (current) to a safe value. The rise in battery voltage during charge is small compared to the voltage drop across the resistance, and the current remains practically constant throughout the charging period. When charging a number of batteries, several may be connected in series. The maximum number of cells that may be charged from a power source is the number obtained by dividing the voltage of the power source by 2.6. In series charging, the batteries must be carefully watched, and as each battery becomes fully charged it must be removed from the circuit.

(3) CONSTANT-VOLTAGE CHARGING. The time required for charging can be reduced by the use of a tapering current. If the power supply has a constant voltage of 2.50 volts per cell, this is accomplished automatically. The initial charging current drops rapidly as the battery charges. Be careful that the initial charging rate is not too high, as evidenced by excessive gassing, otherwise little attention is required for batteries on taper charge.

(4) TRICKLE CHARGING. Trickle charging is the continual application of a very low charging current. This method of maintaining the charge of batteries is not recommended for automotive type batteries.

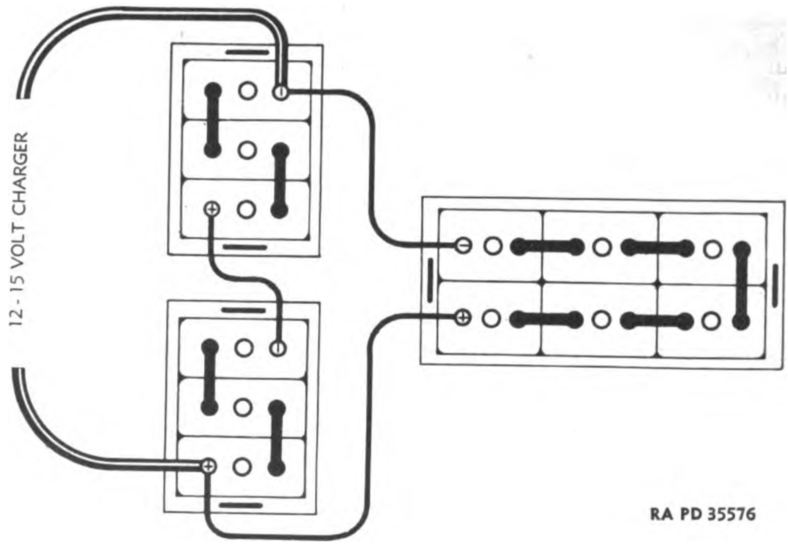


Figure 147 — Charging Two 6-volt Batteries and One 12-volt Battery in Parallel

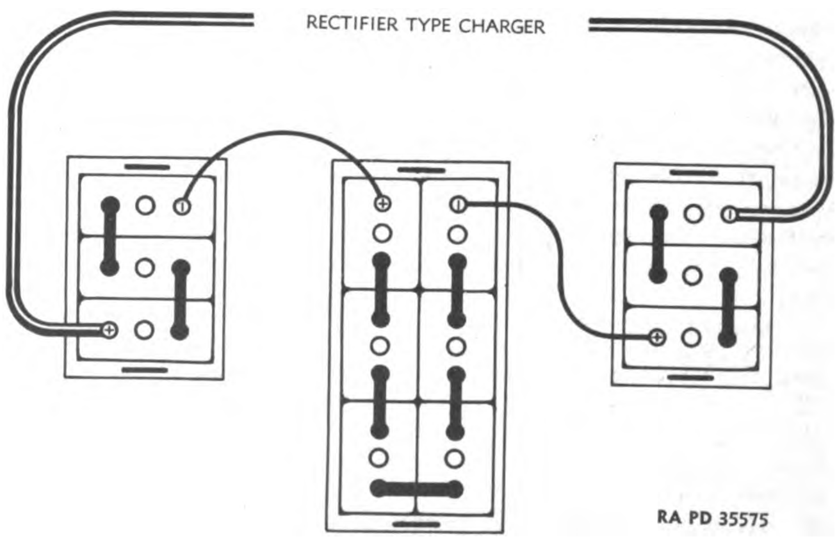


Figure 148 — Charging Two 6-volt Batteries and One 12-volt Battery in Series

d. **Battery Chargers.** Three types of battery chargers are likely to be encountered in ordnance establishments: Motor generator sets which operate from 110 volts alternating current; engine-driven generators; and rectifier-type chargers. The motor generator sets and the engine-driven generators have constant-potential-type generators. They generate at a voltage suitable for charging 12-volt batteries, and have connections for charging 6-volt batteries also. When using these chargers, the batteries are connected in parallel (fig. 147), and care must be taken to avoid overloading the generator. Reduce the generator voltage or limit the number of batteries being charged at one time to reduce the load on the charger. The rectifier-type chargers are of the constant-current type, and are generally limited to low values of current. The batteries are charged in series (fig. 148), and the voltage may be adjusted to suit the number of batteries being charged. Care must be taken when charging batteries in series to have only batteries of approximately the same capacity and condition on charge at the same time. It is possible when charging a strong and a weak battery that the stronger battery will act with the charger, and charge the weak battery with reversed polarity.

e. **Freezing.** A partially discharged battery may freeze in winter. Therefore, in cold weather, keep the battery fully charged. The freezing point of the electrolyte depends on its specific gravity. When fully charged, the electrolyte will remain liquid at extremely low temperatures. A fully-charged battery, if it stands idle long enough, will discharge slowly to a point where freezing may ensue. If the unit is stored for a long time without heat in very cold weather, take the battery to a place where it can be serviced. Water which has been added to a battery and has not been mixed with the electrolyte is likely to freeze if the battery is exposed to low temperature. When batteries have been frozen, they may be thawed by bringing them into a room kept at normal temperature (60 to 70 F). The battery may be serviceable if the freezing has not continued too far. In discharged batteries, the freezing points of electrolytes of various specific gravities are as follows:

Specific Gravity	Freezing Temperatures
1.220	−31 F (−35 C)
1.185	− 8 F (−22 C)
1.150	+ 5 F (−15 C)
1.100	+18 F (− 8 C)
1.000 (water)	+32 F (0 C)

f. **Heating.** Heating of the battery in service above 110 F (125 F in tropics) must be prevented. Watch the battery in warm weather and feel the top connectors. If these are warmer to the touch than the normal temperature of the human body, check the electrolyte with a thermometer. If the temperature reaches 130 F, the battery

may be ruined. Whenever the battery is found to be getting too warm on a run, check the voltage regulator, and cut down the charging rate if possible. If heating continues, check the whole electrical system.

g. **Terminals.** Check battery terminals and keep connections tight and clean. Clean with a solution of AMMONIUM HYDROXIDE or bicarbonate of soda in water and a wire brush. Wash afterwards with water. Lightly coat. terminal with COMPOUND, rust-preventive, light, before tightening. Inspect ground strap and cables, and replace if worn or corroded. Corroded terminals are weakened and easily broken. The positive terminal is more susceptible to corrosion than the negative terminal, due to electrolytic action. Electrolytic action is greater at a loose connection than at a tight one. Loose teminals cause increased resistance, indicated by a decreased capacity and terminal voltage, while other indications show the battery to be normal.

h. **Idle and Stored Batteries.** Batteries should be stored fully charged, and filled with the proper amount of electrolyte. Keep them in a charged condition by periodically charging them every 30 days, or when the specific gravity of the electrolyte falls below 1.225. They will then be available for immediate use when needed.

i. **Reversal of Polarity.**

(1) Reversal of polarity may be indicated by loss of capacity and heating. If it is long continued, the plates may be destroyed.

(2) Reversal of polarity may occur from over discharging when a cell of low capacity is connected in series with cells of higher capacity. The high capacity cells will act to charge the low capacity cell, with the terminals connected in the wrong direction. The most common cause of reversal of polarity is charging the battery in the wrong direction.

(3) REMEDY. If the reversal is not extended over too long a period, the battery may be restored to normal condition by discharging to zero voltage, and recharging in the right direction. Care should be taken to prevent excessive heating and gassing.

j. **Abnormal Sulphation.**

(1) Abnormal sulphation, the hardening or crystallizing of lead sulphate in the plates and possibly on the separators in the cell, may result from prolonged insufficient charge or the addition of acid unnecessarily. It serves as an insulator on the plates and is not readily broken down when the battery is placed on charge. It causes loss of capacity, and if not corrected in time, will make the battery unfit for use.

(2) If a cell is not too badly sulphated, it may be put into condition by recharging. A high rate of charge should be used at the start. If the battery cannot be put into condition by recharging, discard it.

k. Mixing Electrolyte.

(1) Commercial sulphuric acid generally has a specific gravity of 1.835 or 1.400. This acid must be mixed with distilled water to make electrolyte of proper specific gravity for batteries. *Always pour the acid into the water* slowly, and stir to mix. The container should be made of glass, earthenware, lead-lined wood tank, or a similar vessel that is resistant to sulphuric acid and can stand the heat generated during mixing. Allow the electrolyte to cool below 90 F before using. As it cools, its specific gravity will rise slowly. The proportions of water and acid to use depend upon the gravity desired, and are approximately as follows:

PROPORTIONS BY VOLUME

Specific gravity desired	Using 1.400 specific gravity acid: Acid	Using 1.400 specific gravity acid: Water	Using 1.835 specific gravity acid: Acid	Using 1.835 specific gravity acid: Water	Freezing point
1.240	1	3/4	1	3 1/2	–51 F
1.275	1	1/2	1	2 3/4	–85 F
1.300	1	1/3	1	2 1/2	–95 F
1.340	1	1/7	1	2	–62 F
1.400	1	–	1	1 1/2	–33 F

(2) Sulphuric acid or battery electrolyte may cause painful burns if allowed to get on the hands or other parts of the body. Personnel engaged in the handling or mixing of electrolyte should be very careful to avoid injury. Wear goggles, rubber apron, rubber gloves, and rubber boots or rubber overshoes. In case of any accidental spillage on the body, preliminary first aid should consist of immediately flushing the affected areas of the skin with plenty of clean water, followed by a generous application of bicarbonate of soda solution. The sulphuric acid in the electrolyte does not evaporate, so always wash and neutralize spillage with AMMONIUM HYDROXIDE or bicarbonate of soda solution.

(3) When reading the specific gravity of electrolyte, correct the hydrometer reading for the temperature of the electrolyte. For each 10 degrees above 80 F, increase the hydrometer readings by adding 0.004; for each 10 degrees below 80 F, correct by subtracting 0.004. (The accurate correction is 0.00033 per degree F. The above corrections are close enough for the normal range of temperatures.) (fig. 149).

69. PREPARING NEW BATTERIES FOR SERVICE.

a. New batteries, if shipped wet, are always fully charged before shipping, and may be put into service immediately, although a freshening charge is recommended.

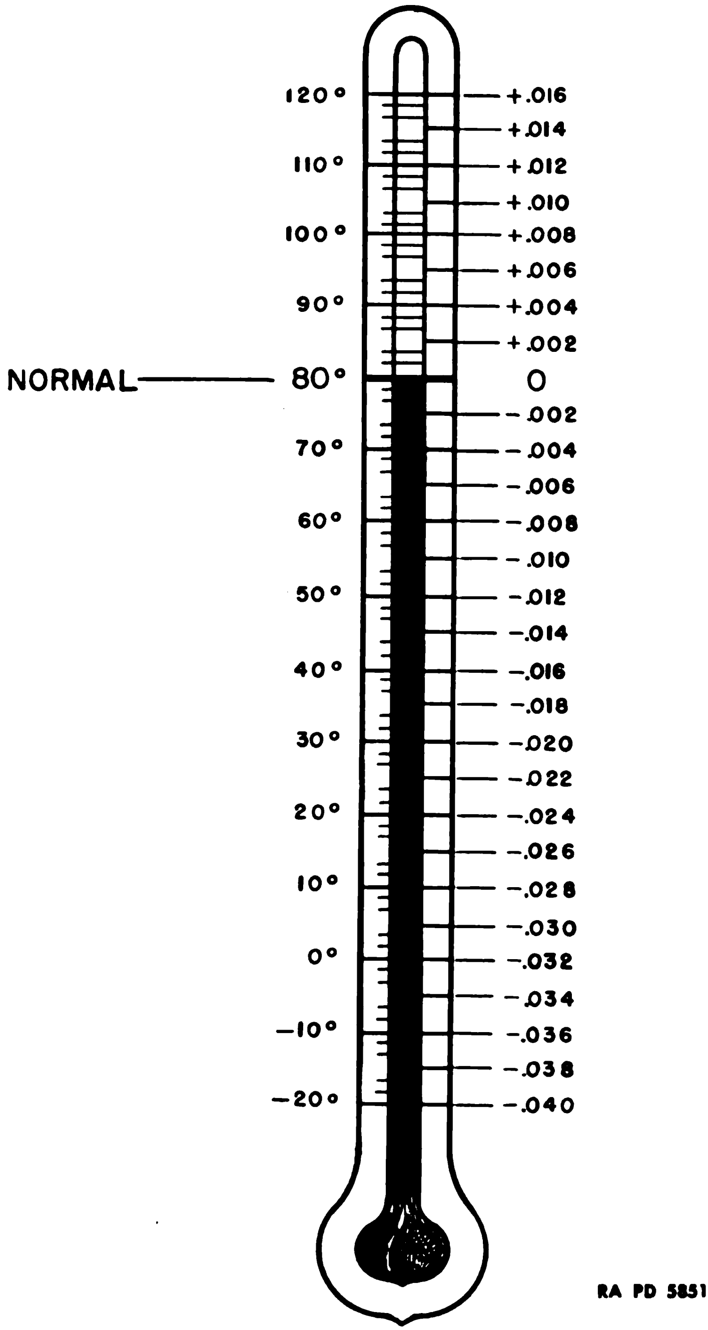


Figure 149 — Hydrometer Correction Chart

b. Batteries shipped without electrolyte in them are generally accompanied by instructions for putting them into service. In general, the following instructions apply:

(1) Batteries shipped dry charged must be filled with electrolyte, and given an initial charge before being put into service. Where the plugs are sealed for shipping and storing, they should not be removed until the battery is to be prepared for use.

(2) Fill each cell with electrolyte (1.270 specific gravity) to the proper level (3/8 inch above separators). Allow the battery to stand at least 1 hour after filling with electrolyte. If the level has fallen, add electrolyte to restore it. Replace vent plugs. The temperature of the electrolyte used for filling the cells should not exceed 90 F. If any electrolyte is spilled on the battery, remove it by wiping with a cloth dampened in a solution of bicarbonate of soda and water.

(3) Charge the batteries at their finishing rate (approximately 1 ampere per positive plate) before placing them in service. Continue charging until 4 consecutive hourly readings show no rise in specific gravity and voltage for the lowest cell. If the above charging rate is maintained, it will take at least 12 hours to complete the charge.

(4) Add only water to restore electrolyte level during charge. After completion of charge the specific gravity should be between 1.270 and 1.285 specific gravity, corrected to 77 F, and with the level of the electrolyte 3/8 inch above the separators. If it is not within these limits, adjust by removing some electrolyte, and replacing with water or electrolyte as required. Charge the battery 1 hour to mix the electrolyte before testing again.

70. BATTERY REPAIR.

a. **General.** Normally, repair will not be attempted when replacement batteries can be obtained. When it is found that one or more cells are defective, and cannot be put in normal condition by charging, a battery may be repaired by replacing the damaged cells, using serviceable cells salvaged from otherwise unserviceable batteries. Such cells should be tested previously for serviceability.

b. **Removal of Defective Cell From Battery.**

(1) Drill out the connector over the top of the cells to disconnect the cells.

(2) Scrape away the sealing compound used to seal the covers to the container.

(3) Remove assembly of plates, separators, and cover from the cell as a unit and discard.

(4) Remove the electrolyte from the compartment with a syringe, and discard.

c. Installing a Salvaged Cell.

(1) Remove salvaged cell. Follow procedure outlined in subparagraph b, above, except that electrolyte is not to be discarded.

(2) Place the assembly of cell elements in the container, making sure the negative and positive poles are in correct position.

(3) Place heated COMPOUND, battery-sealing, around top of covers, sealing them to the container.

(4) Fuse the connectors to the terminal posts, connecting the cells in series.

(5) Pour the electrolyte from the salvaged cell into vent opening until the tops of the separators are covered by approximately ⅜ inch. If new electrolyte is used, it should not be over 1.200 specific gravity.

(6) Charge the battery until fully charged, as indicated by no rise in the specific gravity of the electrolyte in four successive hourly readings. Adjust specific gravity of electrolyte (par. 69 b (4)).

Section VII

ELECTRICAL SYSTEM — IGNITION

71. DESCRIPTION.

a. The engine ignition system consists of an ignition coil, distributor, condenser, spark plugs, and connecting wires. Its function is to provide electric current for the operation of the engine.

b. The ignition coil is a self-contained unit consisting of an iron core around which are wound a few turns of heavy wire to form a primary circuit, and many turns of fine wire to form the secondary circuit. The core and wires are enclosed in a sealed case to form the complete coil. Its function is to step up the low voltage current of the primary circuit to the high voltage current of the secondary circuit, which is needed to produce a spark across the points of the spark plugs by which the explosive mixture in the cylinder is ignited.

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c. The distributor consists of a housing in which is enclosed a pair of electrical contacts known as breaker points. A vertical shaft, driven by a gear on the engine camshaft, extends through the distributor housing. A cam is attached to this shaft within the housing, and is the means by which the breaker points are opened at proper intervals. Another contact, known as a rotor, is attached to the upper end of this shaft. A cap is attached to the top of the housing, and provides the means of connecting wires from the spark plugs to the distributor. It is important that the breaker points open at exactly the right instant to send the high tension current from the coil to the spark plug, causing ignition just when the piston is in the proper position. The function of the breaker points is to open the circuit in the primary of the ignition coil. This causes the field of magnetism around the core to collapse through the many turns of fine wire in the secondary. This collapse of field, which is "boosted" by the action of the condenser, causes a surge of high voltage current in the secondary. This high tension current travels from the coil to the distributor rotor, which is so positioned by the shaft holding the cam which actuates the breaker points, that the current must proceed through the proper connecting wire, to the spark plug which is in the cylinder that is ready for firing.

d. A condenser is mounted on the lower half of the distributor and its wire is attached to a terminal at the top of the distributor housing. Its function is to stop the flow of low tension current across the distributor points the instant the points are opened. This permits more rapid energization of the secondary windings in the coil, and at the same time prevents burning the distributor breaker points.

e. The spark plug consists of a metal shell within which is located an insulator having a central electrode stem. The shell is threaded at the lower end to permit screwing into the cylinder head. The lower end of the shell carries a fixed, bent electrode extending from the side of the shell inward toward the central electrode stem located in the insulator. These electrodes are separated by an air gap. The top end of the central electrode is where the wire from the distributor is attached.

72. TROUBLE SHOOTING.

a. Ignition Coil.

Possible Cause	Possible Remedy
(1) ENGINE FAILS TO FIRE.	
Excessive moisture on end of coil.	Wipe coil clean and dry.
Open circuit in primary or secondary circuit, or either circuit grounded outside of coil.	Check and tighten connections.
Windings grounded inside of coil.	Replace coil.

Possible Cause	Possible Remedy
Short-circuited turns in primary or secondary windings, or high voltage break-down in secondary windings.	Replace coil.

(2) ENGINE MISSES (WEAK SPARK).

Internal short circuit in coil.	Replace ignition coil.

b. Distributor.

(1) ENGINE WILL NOT START.

Breaker points not closing.	Check and adjust breaker points. Replace, if necessary.
Breaker points worn.	Check breaker points, and replace, if necessary.
Breaker point lever grounded.	Replace breaker points.
Worn rotor or cap.	Examine and replace rotor or cap.

(2) ENGINE MISFIRES IN ONE OR MORE CYLINDERS.

Broken cap or rotor.	Replace cap or rotor.

(3) ENGINE MISSES AT LOW SPEED.

Breaker point gap too small.	Check and adjust gap (0.020 inch).

(4) ENGINE MISSES AT HIGH SPEED UNDER LOAD.

Breaker lever spring tension spring weak.	Replace breaker points.
Breaker point gap too large.	Adjust gap (0.020 inch).

(5) WEAK SPARK AT PLUGS.

Breaker cam worn.	Install new cam assembly.
Breaker contact points worn or pitted.	Examine, and replace contact points.
Condenser shorted or disconnected.	Test connection or replace condenser.

(6) TIMING INCORRECT OR IRREGULAR.

Breaker cam loose or wobbly.	Replace bushings in distributor housing.

c. Spark Plug.

(1) ENGINE MISSING SLIGHTLY; SLUGGISH OR IRREGULAR PERFORMANCE.

Improper spark plug gap.	Adjust spark plug gap to 0.025 inch.
Loose leaky spark plug threads.	Tighten or replace plugs or gaskets.
Dirty spark plugs.	Clean and adjust spark plugs.

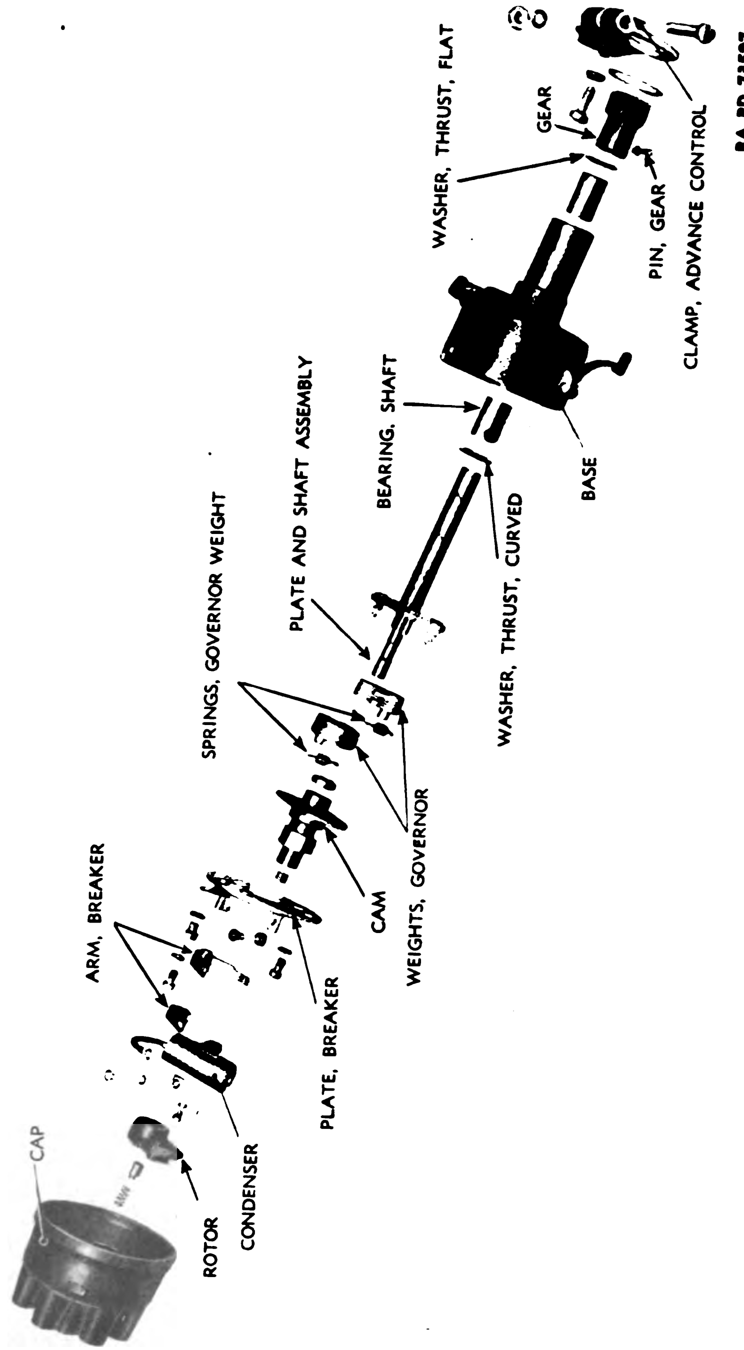


Figure 150 — Distributor — Exploded View

Possible Cause	Possible Remedy
(2) FAILURE TO GIVE SPARK.	
Insulation broken.	Replace spark plug.
Side electrode worn excessively.	Replace spark plug.
Plug carbonized at inner end.	Clean spark plug.
Insulation swollen, blistered, fused, or broken.	Replace spark plug.
Electrodes showing signs of disintegration.	Replace spark plug.
Leak around insulation, showing carbon streaks on outside.	Replace spark plug.
Moisture on outside of spark plugs.	Wipe dry.
Points forced into contact due to careless handling, when plug was installed.	Separate points, and adjust gap (0.025 inch).
(3) ENGINE MISSING AT LOW SPEED ONLY.	
Insulator cracked at point outside of engine.	Replace spark plug.

73. IGNITION COIL.

a. Inspection.

(1) Remove coil and place in coil tester. Check spark gap while running free and under load. If spark will jump a ¼-inch gap under load, coil is suitable for further service.

NOTE: In the absence of coil testing equipment, compare performance with another coil known to be good. Replace coil, if performance is not equal to that of the ignition coil known to be good.

74. DISTRIBUTOR REMOVAL (figs. 26 and 27).

a. Procedure.

(1) Snap out lead connections from distributor cap. Loosen vertical cap screw in arm below distributor, and loosen horizontal bolt at right. Loosen iron collar below clamp, and remove distributor.

75. DISTRIBUTOR DISASSEMBLY (fig. 150).

a. Procedure.

(1) Snap down the two distributor cap springs, and lift the cap off the distributor.

(2) Lift rotor up from shaft and remove (fig. 151).

(3) Take out the two screws which hold breaker plate assembly to shaft and governor assembly. Lift breaker plate assembly out of base (fig. 152).

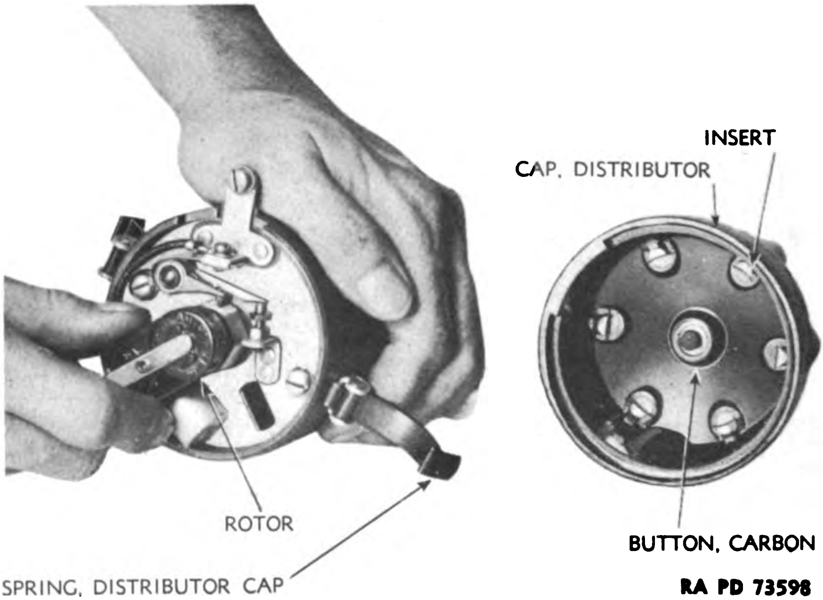


Figure 151 — Lifting Off Rotor

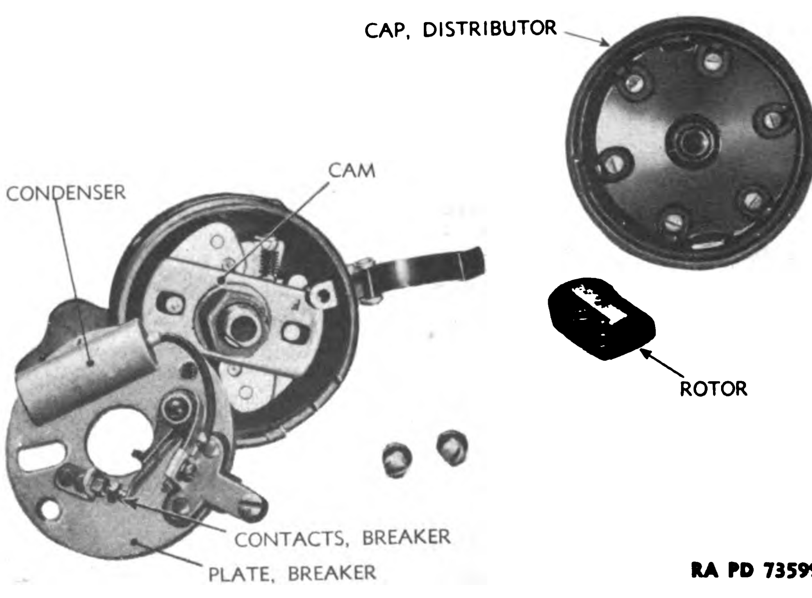


Figure 152 — Breaker Plate Assembly Removed

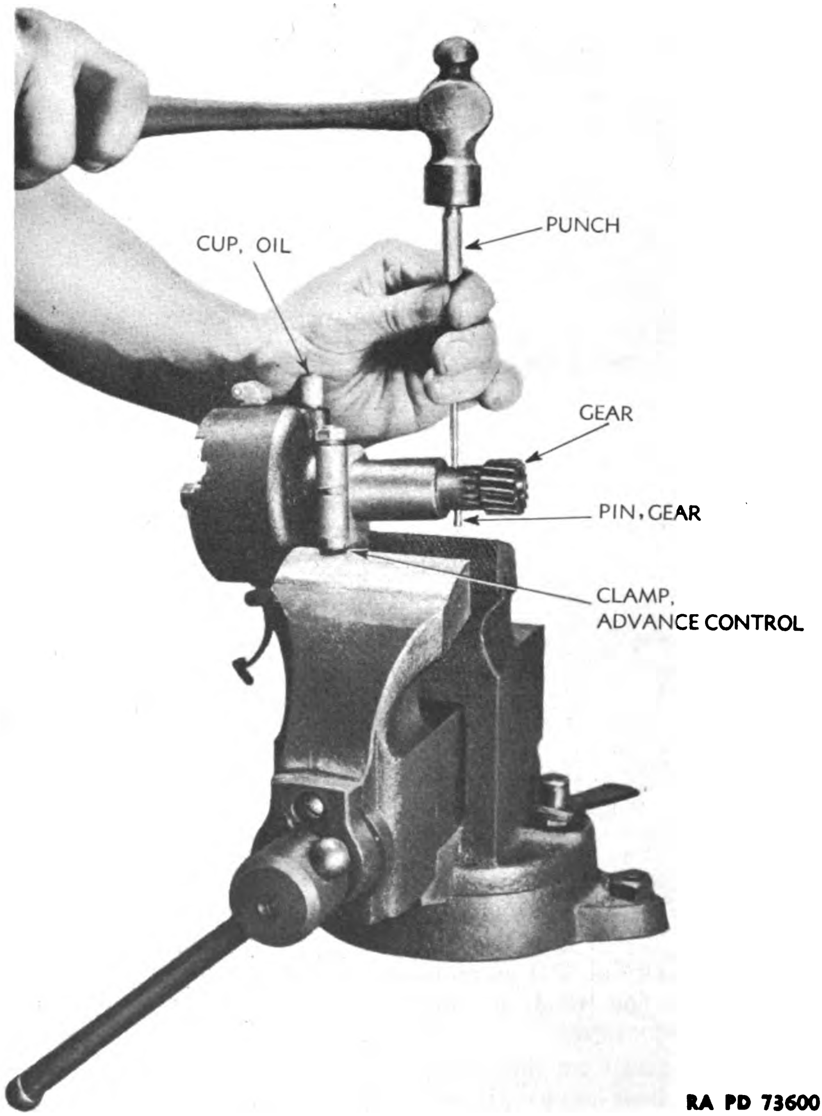


Figure 153 — Driving Out Distributor Gear Pin

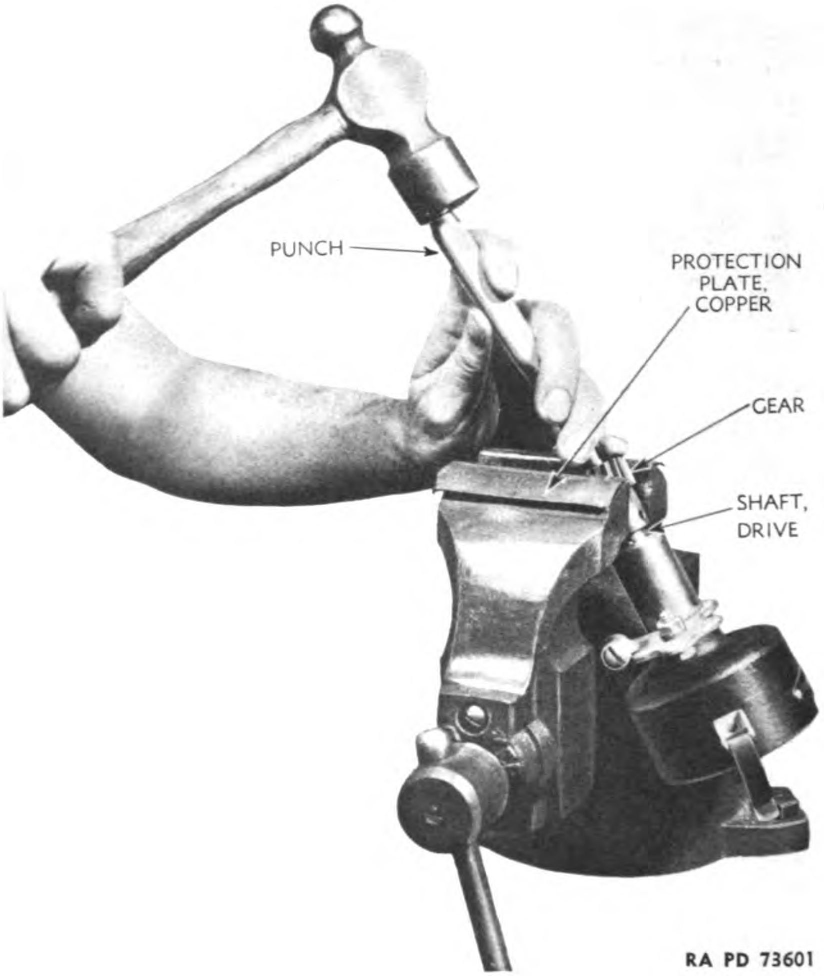


Figure 154 — Driving Distributor Shaft from Gear

(4) File off one end of peened-over pin attaching gear to shaft, drive out pin (fig. 153), and drive shaft from gear (fig. 154). Remove gear and washer.

(5) Lift cam from shaft and governor assembly (fig. 155).

(6) Pull shaft and governor assembly out of base. Remove curved thrust washer.

(7) Remove weight springs from governor and slide weights off pivots (fig. 156).

(8) Remove stationary contact lock nut and stationary contact.

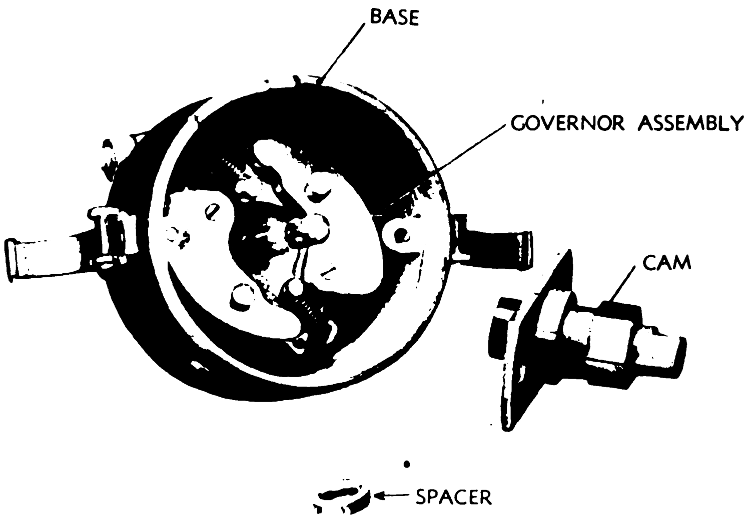


Figure 155 — Distributor Cam Removed

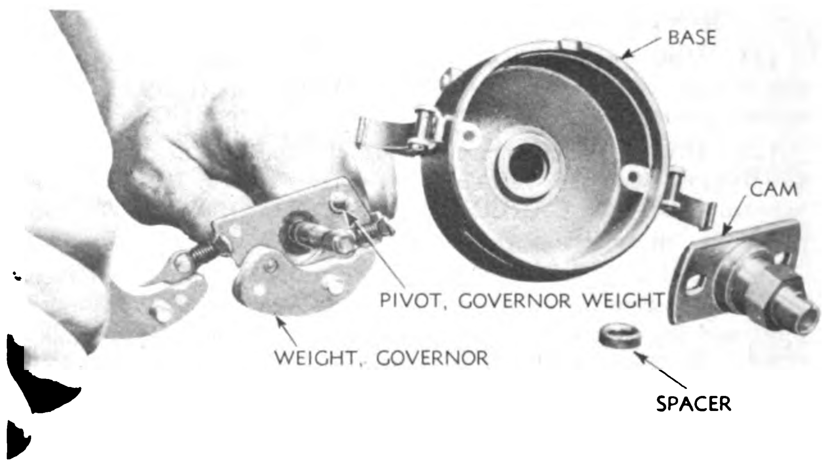


Figure 156 — Removing Distributor Weights

Remove condenser mounting screw and lock washer. Lift condenser from breaker plate (fig. 157).

(9) Remove breaker arm spring screw and breaker arm spring clip, and lift breaker arm from its pivot.

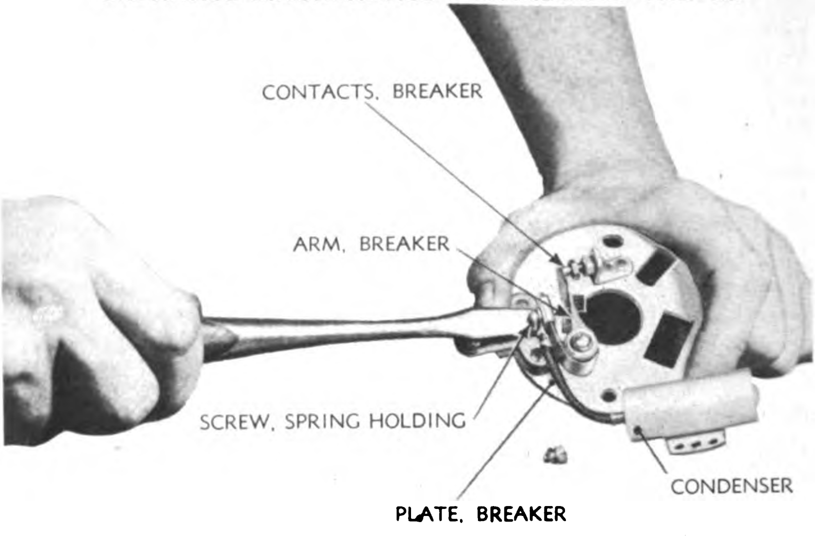


Figure 157 — Removing Condenser from Breaker Plate

76. DISTRIBUTOR INSPECTION AND REPAIR.

a. Distributor Cap.

(1) Visually inspect distributor cap for cracks, carbon streaks, and corroded high tension terminals. Replace cap, if any of these conditions are found.

(2) Inspect the inserts on inside of cap. After a distributor has had normal use, the vertical face of the inserts becomes slightly burned. Clean with CARBON TETRACHLORIDE. NOTE: Do not file. If the burning is excessive, replace the cap.

(3) Examine inserts for signs of burning on horizontal faces. If burning is noticeable at this point, it is an indication that gap between rotor and insert is too large. Replace both cap and rotor, if this condition is found.

b. Rotor. Inspect rotor for cracks, and replace, if any are found. Inspect contact for evidence of burning on top of metal strip. After normal use, the end of the metal strip will become slightly burned. Clean with CARBON TETRACHLORIDE. If evidence of burning is found on top of metal strip, replace rotor and cap.

c. Condenser.

(1) Check the condenser on an M1 Circuit Tester. Connect bare clip of low tension lead to a ground on engine; connect red clip to battery or starting switch terminal. Insert condenser in the clip on tester, and attach short test lead to condenser pigtail.

(2) Place coil test switch at "test coil."

(3) Turn on rotor switch.

(4) Adjust variable spark gap to highest setting obtainable without missing.

(5) Move condenser test switch to "vehicle cord," and observe effect on high-tension output and on arcing at tester breaker contacts. Repeat test several times, changing position of condenser pigtail lead. If switching to "vehicle cord" does not result in arcing and spark does not miss, condenser is satisfactory. If arcing does occur or spark misses, condenser is not functioning normally and must be replaced. If moving condenser lead affects action, it indicates a faulty lead, and condenser must be replaced.

d. **Breaker Contacts.** Inspect the breaker contacts. If they are a grayish color and only slightly pitted, they need not be replaced. Make sure breaker arm turns freely on its pivot without excessive side play. Replace rough or pitted breaker contacts. If it is necessary to reinstall the old breaker contacts, hone them on a stone before reinstalling, to a smooth, flat surface. NOTE: Do not file.

e. **Shaft and Governor.** Clean the parts thoroughly in SOLVENT, dry-cleaning. Inspect governor weights and plate for wear. Inspect springs for distortion. Replace damaged parts. Pack pocket in the laminated weights with GREASE, general purpose (seasonal grade), and reassemble governor, making sure weight spring has the small loop on the weight pin.

f. **Base.**

(1) Clean the base thoroughly in dry-cleaning solvent, and inspect for evidence of breakage. Make sure the cap spring lugs are riveted tightly. Replace base if rivets are loose.

(2) Place shaft and governor in base and, with a dial indicator, measure side play of shaft. Clamp indicator to base with the point against shaft. Move shaft sideways and read indicator. If side play in any direction is over 0.005 inch, replace bearings.

(3) Drive bearings out of base and install new bearings (arbor press). Place bearing on the press, and press into base. Make the lower bearing flush with base; countersink upper bearing.

g. **Cam.** Clean cam and stop plate in dry-cleaning solvent. Inspect cam and weight slots for evidence of wear. Replace cam if worn or if slots do not have smooth, straight sides.

h. **Breaker Plate.** Clean breaker plate in dry-cleaning solvent, and inspect for stripped threads, bent breaker pivot, and bent or distorted primary terminal. With test lamp, check terminal for grounds. Touch one probe to plate, and other probe to the terminal. If lamp lights, the terminal is grounded, and plate must be replaced.

77. DISTRIBUTOR ASSEMBLY (fig. 150).

a. Procedure.

(1) Soak drive shaft bearings in OIL, engine (crankcase grade), and wipe drive shaft with same grade of oil. Install shaft and governor in base with the curved thrust washer between weight carrying plate and base.

(2) Place flat thrust washer and gear on bottom of the shaft and insert coupling pin. Peen the pin on both ends.

(3) With a dial indicator, measure end play of shaft. Limits are 0.003 to 0.010 inch. If end play exceeds 0.010 inch, remove coupling and install additional thrust washers

(4) Assemble cam and stop plate to shaft and governor.

(5) Assemble condenser and breaker contacts to breaker plate, and install screw holding breaker spring and condenser lead.

(6) Place breaker plate in base, and secure to base with hold-down screws. Place rotor on the shaft.

(7) Bend stationary contact bracket so that points make full surface contact. NOTE: Do not bend breaker arm. Use thin washer under arm to obtain alinement.

(8) Turn shaft to position breaker arm rubbing block on one of the lobes of cam, and adjust stationary contact so gap is 0.020 inch. Use feeler gage to measure gap (fig. 71). After adjusting gap, tighten the lock nut, and recheck.

(9) Turn shaft so rubbing block is on the flat side of cam. Using a spring scale, measure breaker arm spring tension. Hook the scale to breaker arm at contact end, and pull on a line perpendicular to contact surfaces. Take reading just as contacts separate. Loosen the spring holding screw and slide the end of the spring in or out, as necessary, to get a reading of 17 to 20 ounces.

(10) Add 6 to 8 drops of OIL, engine (crankcase grade), to the oiler. Add 1 or 2 drops only to breaker arm pivot and to governor weight pivots and slots. Apply 1 or 2 drops to the felt in top of cam. Wipe cam with GREASE, general purpose (seasonal grade).

78. DISTRIBUTOR TESTS AND ADJUSTMENTS.

a. Procedure.

(1) Place distributor on a distributor test fixture, and set controls to measure cam angle or dwell. Operate the distributor up and down the speed range, and note fluctuations in the meter. Excessive fluctuation is caused by a worn cam or sticking contact arm on its pivot. Adjust the reading to 41 degrees by changing contact point gap. Tighten the lock nut after each adjustment. (This operation can be done on the truck if only the M1 Ignition Circuit Tester is available.)

(2) Adjust the centrifugal advance. This operation can be done only on a fixture that will show the firing point in degrees, and the distributor speed in revolutions per minute.

(a) Run the distributor at 250 distributor revolutions per minute, and set dial at 0 degree.

(b) Increase speed up to 1,150 revolutions per minute, and note advance. Specifications are 6 distributor degrees. If maximum advance is not within specifications, reduce speed below 300 revolutions per minute, and note whether or not degrees indicator drops below zero. If an indication below zero is shown, stop distributor. Bend lugs on outer spring bracket slightly, and again check at 1,150 revolutions per minute. If advance is still not 6 degrees, stop distributor and relieve spring tension slightly by bending the outer spring bracket. Advance specifications at distributor revolutions per minute are as follows:

0°	at 300 rpm
1°	at 450 rpm
3°	at 725 rpm
5°	at 1,000 rpm
6°	at 1,150 rpm

79. DISTRIBUTOR INSTALLATION.

a. Procedure.

(1) Remove the number one spark plug. Close plug hole with thumb, and turn the engine over with the hand crank until the piston is at top dead center on the compression stroke. Compression can be felt and number one piston top dead center can be checked by a white spot showing on the flywheel when it is viewed through a 1-inch diameter peephole in the left side of the flywheel housing (fig. 72). While the distributor is off the unit, set the rotor at the number one firing position.

(2) Let distributor down into position in tachometer drive. Tighten bolt on iron collar below flange. Attach distributor arm to tachometer collar arm with cap screw and nut. Tighten horizontal bolt. **NOTE:** If the unit does not have a tachometer, the distributor drive, with gear attached, goes directly into the hole provided through the water pump drive housing to mesh with gear provided on the water pump drive.

(3) Time ignition (par. 27 a (9)).

80. SPARK PLUGS.

a. Spark Plug Inspection and Repair (100 Hour).

(1) Examine the manufacturer's symbols on spark plug porcelain. Replace spark plug with proper type, if wrong type is in use. Spark

plug should be Champion No. 1, common, or equivalent. This is a cold plug. Under no circumstances should a hot plug be used.

(2) Examine the electrodes. Replace plugs if electrodes are burned.

(3) Examine spark plug porcelains. Replace plugs if porcelains are cracked or broken. Note the color of the porcelain at center electrode tip. A dead white color indicates that the plug is running hot. Replace this plug with another of the same type. If after a period of running at normal speed, this plug also shows a dead white color or scaling, this is too hot a type plug, and must be replaced with a colder type. A light brown color indicates the plug is operating correctly. A glossy black deposit indicates an excessive amount of oil in the combustion chamber. Check piston rings and pistons. Correct the fault. A dull black deposit indicates a rich fuel mixture, weak ignition, improper spark plug gaps, or weak compression. Locate and correct the cause.

(4) Clean each spark plug in a sand blast spark plug cleaner. After doing so, file the oxide from between the points.

(5) Measure gap between electrode of each spark plug with a wire type feeler gage. Proper clearance is 0.025 inch. Bend electrode attached to metal base of spark plug until proper gap is obtained.

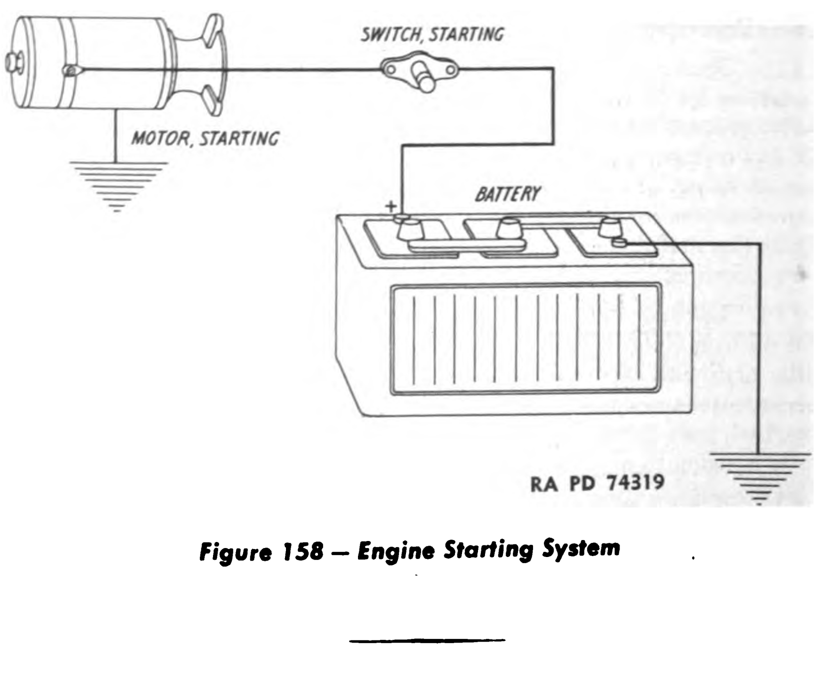


Figure 158 — Engine Starting System

ENGINE AND ACCESSORIES

Section VIII

ELECTRICAL SYSTEM — STARTING MOTOR

Paragraph

81. DESCRIPTION.

a. **General.** The starting motor, the battery, and the starting switch on the instrument panel make up the engine starting system (fig. 158).

b. **Motor.** The starting motor (fig. 159) is of the four brush type with a Bendix drive. It is mounted on the flywheel housing at the lower left-hand side of the engine. The motor consists of a frame and field assembly, armature, and end plates. The four pole pieces and the four field coils are mounted in the frame. The field coils are connected in series. One lead of the coils is connected to an insulated terminal post, which passes through the frame. The other lead is connected to the brushes, which are held in brush holders in the commutator end plate. The commutator end plate is held to the frame.

c. **Drive.** The Bendix drive is mounted on the drive end of the armature. It gears the starting motor to the engine (fig. 159) when the starter switch is closed, and releases it when the engine is started. It consists of a gear mounted on a hollow spiral shaft, connected by splines to the armature shaft.

82. TROUBLE SHOOTING.

a. **Starting Motor Fails To Operate.**

Possible Cause	Possible Remedy
Battery discharged.	Recharge battery (par. 68 c).
Loose and dirty connections.	Clean and tighten connections.
Bendix gear jammed.	Free gear from flywheel.
Starting motor switch faulty.	Replace switch.
Bendix drive inoperative.	Remove starter, and repair or replace Bendix drive.

b. **Starting Motor Cranks Weakly.**

Battery weak.	Recharge battery (par. 68 c).
Loose or dirty connections.	Clean and tighten connections.

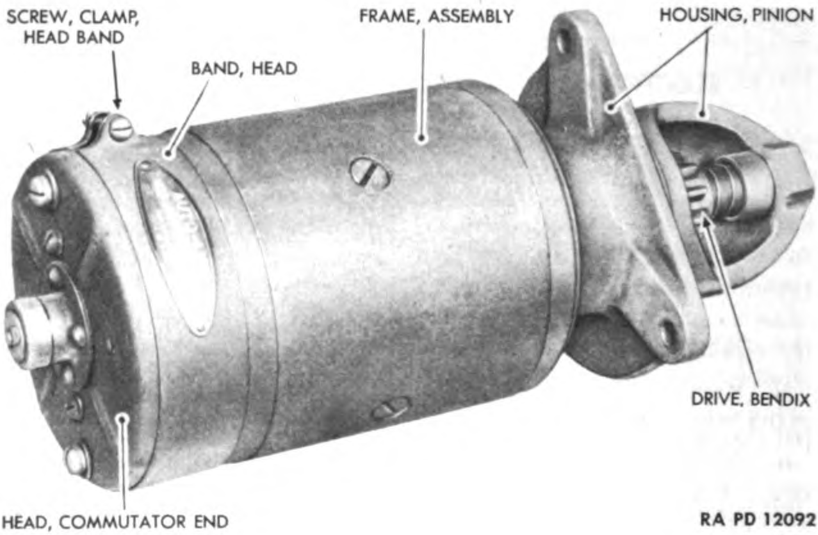


Figure 159 — Starting Motor Assembly

Possible Cause	Possible Remedy
Commutator dirty.	Clean commutator with SAND-PAPER, flint, Class B, No. 2/0.
Starting motor inoperative.	Remove, repair, or replace starting motor.

c. Bendix Drive Fails To Operate When Starting Motor Revolves.

Dirty or gummy Bendix drive.	Remove starting motor. Clean drive.
Drive spring broken.	Remove starting motor, and replace drive spring.

83. DISASSEMBLY.

a. Procedure.

(1) Loosen head band clamp screw, and lift off band.

(2) Disconnect field coil lead to insulated brushes.

(3) Remove the two frame screws (fig. 160). Hold up brushes, then pull commutator end head from the motor (fig. 161). Lift thrust washer from armature.

(4) Lift off the pinion housing.

(5) Pull the armature assembly out of the frame.

(6) Remove shaft spring screw and head spring screw. Pull pinion assembly off armature shaft, and remove drive spring. Remove

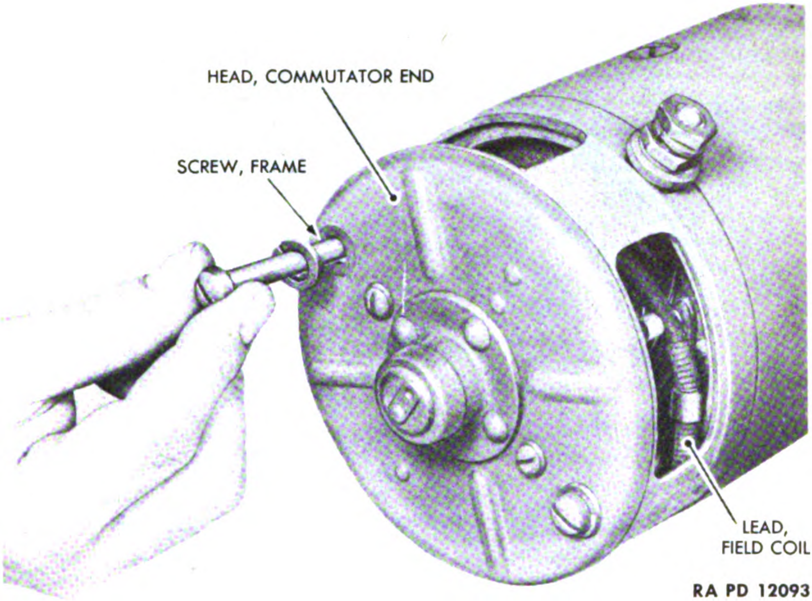


Figure 160 — Removing Frame Screw

dowel pin from head, and Woodruff key from armature shaft. Press head and intermediate bearing off armature.

(7) Remove brush screws. Remove brush lead ground screws. Lift out brushes and ground connectors. Pull brush-holder post clips off posts. Remove insulating washers, insulating bushings, brush springs, brush arms, spring insulators, and brush holder spacing insulators (figs. 162 and 163).

84. INSPECTION AND REPAIR.

a. Armature.

(1) Clean Commutator. If commutator is dirty or discolored, hold a piece of PAPER, flint, Class B, No. 2/0, against the commutator while turning armature slowly. Blow sand off commutator after dressing.

(2) Repair of Rough or Worn Commutator. If commutator is rough or worn, place armature in a lathe. Mount armature on bearing seats. Take as light a cut as possible to remove roughness. Do not undercut mica between commutator bars. NOTE: Lathe cutting tool must be sharp to avoid burring commutator. If burs are present after taking the cut, replace armature.

(3) Test Armature for Grounds. Hold one point of test lamp to the core or shaft (not on bearing surfaces). Touch each commuta-

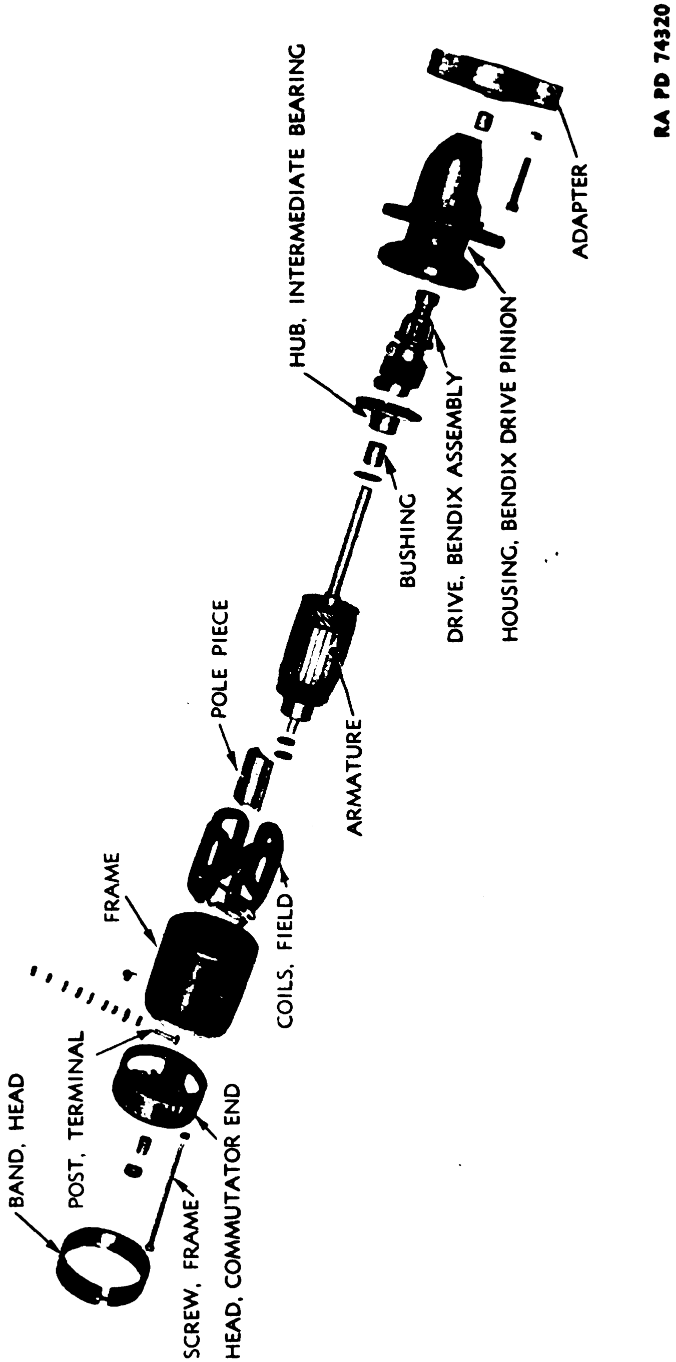


Figure 161 — Starting Motor — Exploded View

ENGINE AND ACCESSORIES

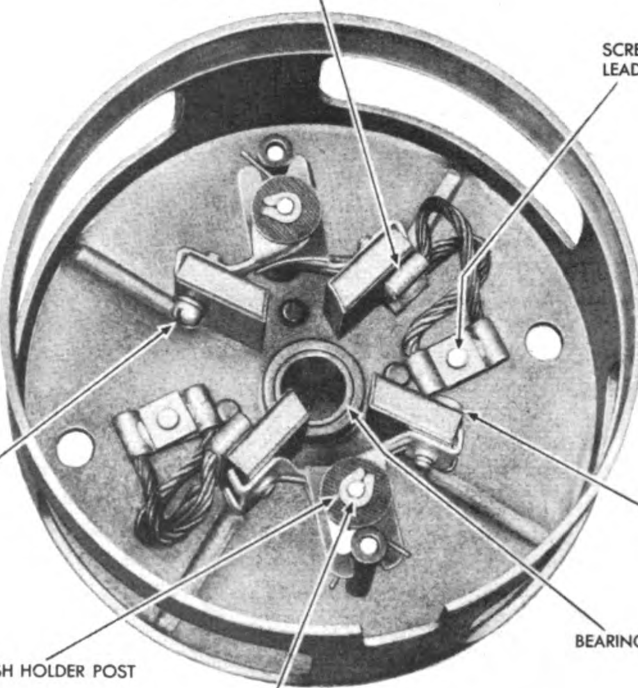


Figure 162 — Commutator End Head Assembly

tor segment with other point of test lamp (fig. 164). If lamp lights at any time, the winding is grounded. Replace armature if grounded.

(4) TEST ARMATURE FOR SHORTS. Place armature on a growler. Hold a thin strip of steel on the core. Rotate armature slowly by hand. If steel strip vibrates, armature is shorted. Replace armature if shorted.

b. Frame and Field.

(1) Test frame and field coils for shorts. Bend the two leads so that neither touches frame or field. Hold one point of test lamp on frame. Touch terminal post with other test lamp lead. If test lamp lights, a short circuit is present. To locate the short circuit, disassemble terminal post and repeat test. If test lamp still lights, short circuit is in field coil. If it no longer lights, the short circuit is in terminal post.

(2) Test field coil and leads for open circuit. Hold one point of test lamp on terminal post. Touch each lead, in turn, with the other

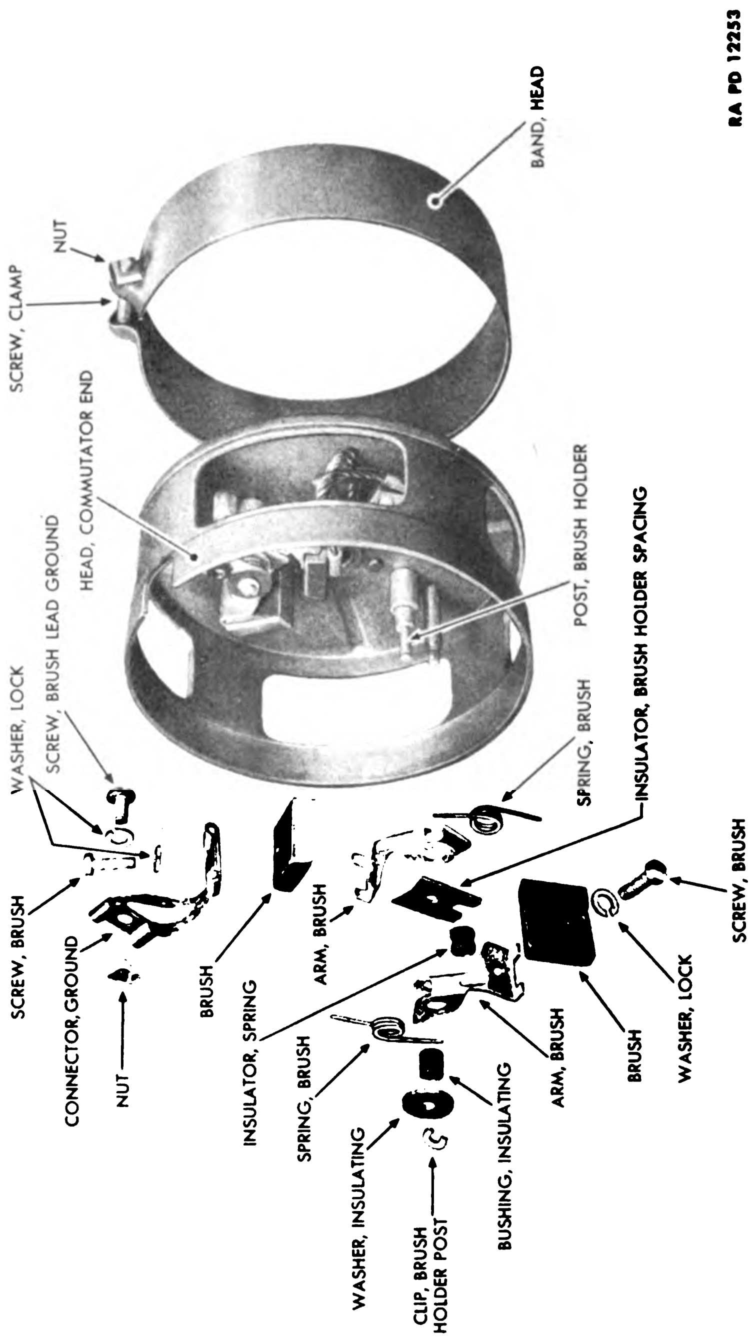


Figure 163 — Commutator End Head Assembly — Exploded View

point of test lamp. If test lamp fails to light in either instance, a field coil or lead is open.

(3) Repairing a short or open circuit in frame assembly.

(a) Disassemble frame assembly (fig. 165). Remove two nuts, insulating washer, and terminal post cover insulation from terminal post, and remove the four pole piece screws. Lift pole pieces and coils from frame. Lift terminal post frame insulation, insulating washer, and flat washer from terminal post.

(b) Repair shorted terminal post. Use two new insulating washers, new terminal post frame insulation, and new terminal post cover insulation on terminal post. Assemble frame assembly.

(c) Repair shorted field coil Replace field coils and assemble frame assembly.

(d) Repair open circuit. Melt solder on connections and disconnect the four field coils. Touch one point of test lamp to bare wire at one end of coil. Touch other point of test lamp to bare wire on other end of coil. Repeat test on each coil. Replace each coil on which test lamp fails to light. Connect field coils. Clean ends of all wires to be connected, clinch connections securely, and solder.

(e) Assemble frame assembly (figs. 165 and 166). Place the flat washer, insulating washer, and terminal post frame insulation on the terminal post. Place the field coils, insulation, and pole pieces in position in frame. Dip pole piece screws in VARNISH, shellac. Install the pole piece screws. Strike the frame a few sharp blows with a rawhide mallet as the screws are being tightened to aline pole pieces. Install terminal post cover insulation, insulating washer, lock washer, nut, second lock washer, and second nut on the terminal post.

c. **Pinion Housing** (fig. 167).

(1) Clean pinion housing in SOLVENT, dry-cleaning, and dry with compressed air.

(2) Examine pinion housing for fractures. Replace if broken.

(3) Fit armature shaft into the end bearing and check side play. If side play is more than barely perceptible, drive old bearing out and press in a new one. Press bearing flush with outer ends of bore in housing.

d. **Bendix Drive and Intermediate Bearing Plate.**

(1) Examine all parts to see if any are bent, broken, chipped, or worn. Replace damaged parts. Clean all parts in SOLVENT, dry-cleaning, and dry with compressed air.

(2) Inspect the intermediate bearing plate for wear or distortion. Fit intermediate bearing on armature shaft and check for side play. Replace intermediate bearing plate if side play is more than barely perceptible. Spin plate on shaft, and note if it is warped. Replace plate if it is not true.

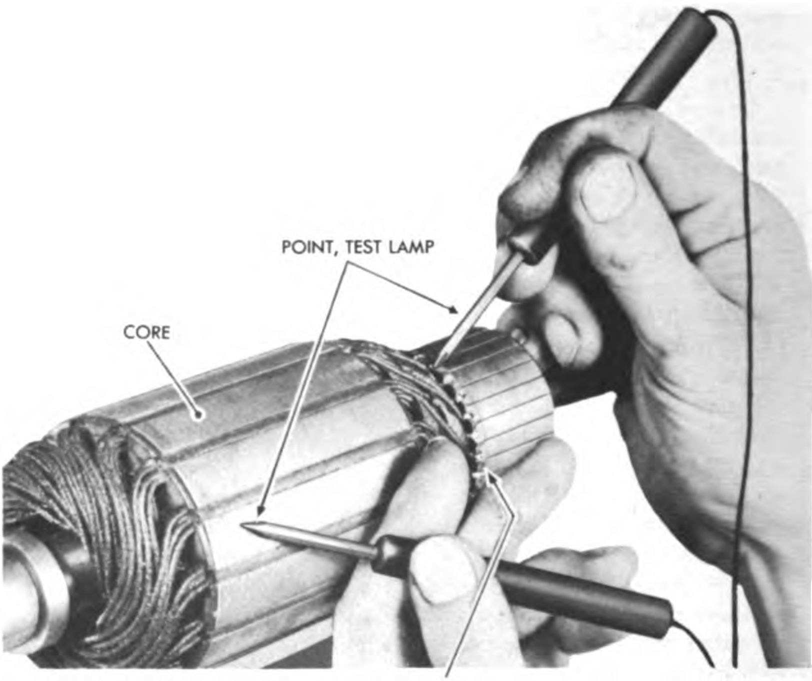


Figure 164 — Testing Armature for Ground

e. Commutator End Head.

(1) Clean commutator end head and all parts except brushes in SOLVENT, dry cleaning. Blow dry with compressed air.

(2) Inspect all parts for scoring, distortion, and breakage.

(3) If brushes are worn to less than half their original length, replace with new ones. Compare the old brush with a new one to determine the amount of wear.

(4) Fit armature shaft into bearing. If there is any perceptible side play, replace commutator end head.

85. ASSEMBLY.

a. Procedure.

(1) Install brush-holder spacing insulators, spring insulators, brush arms, brush springs, insulating bushings, and insulating washers in commutator head. Install brush holder post clips on posts.

(2) Place brushes and ground connectors in position in commutator head. Install brush lead ground screws. Install brush screws.

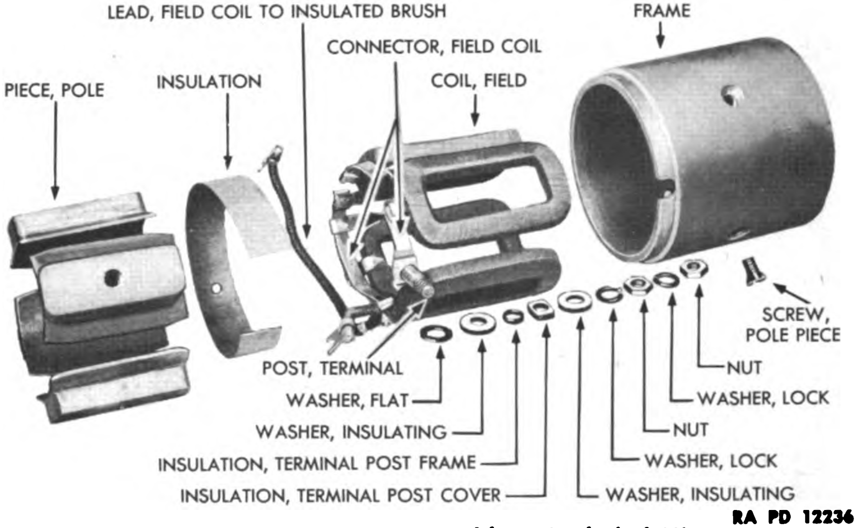


Figure 165 — Frame Assembly — Exploded View

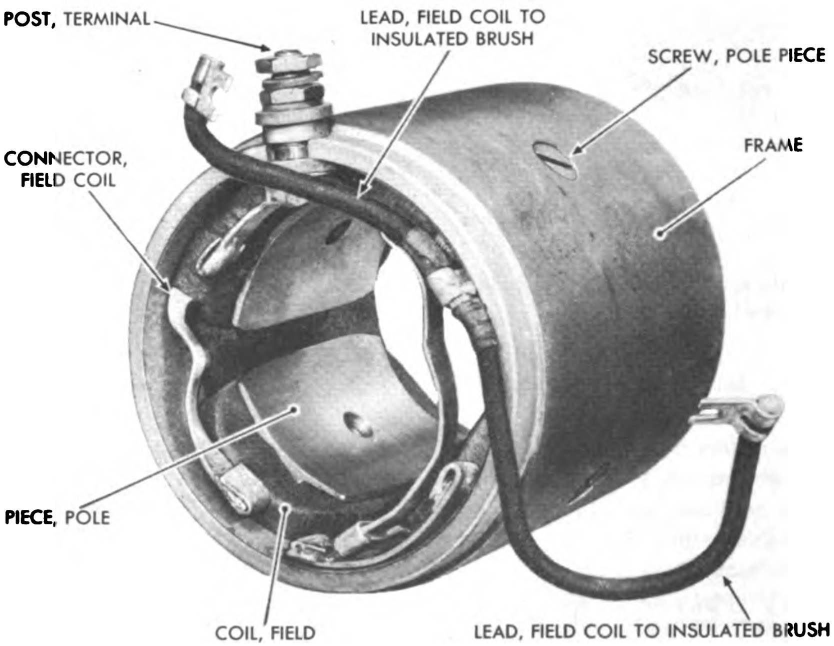


Figure 166 — Starting Motor Frame Assembly

(3) Soak all bearings in OIL, engine, SAE 10, and apply a light wipe of oil to armature shaft bearing seats.

(4) Assemble intermediate bearing plate on armature shaft.

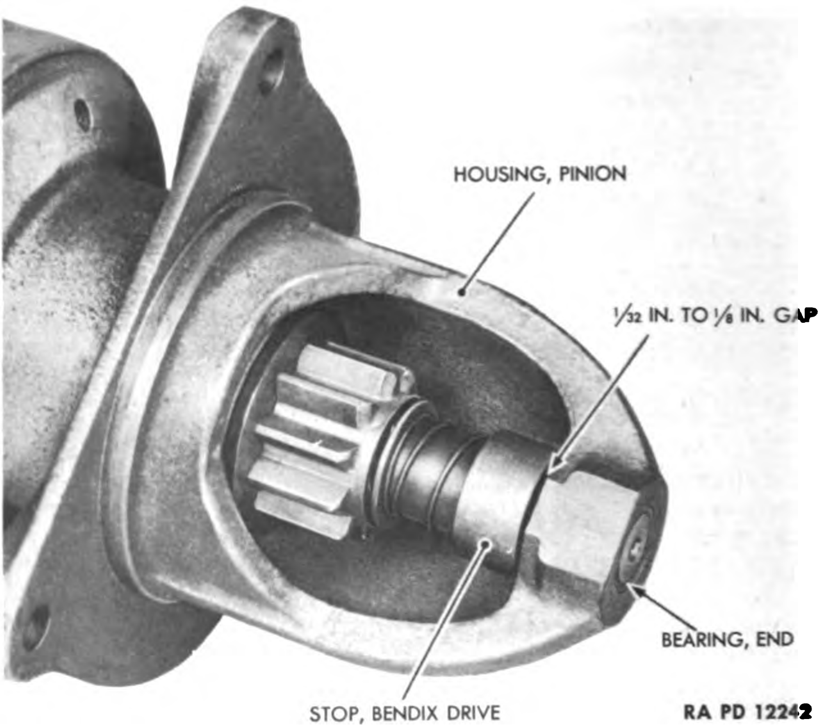


Figure 167 — Starting Motor Pinion Housing

(5) Install dowel pin in Bendix head, and Woodruff key in armature shaft.

(6) Press intermediate bearing plate and head on armature shaft.

(7) Install drive spring on armature, and then install pinion assembly.

(8) Install head spring screw and shaft spring screw, and tighten. Lock screws with special lock washers.

(9) Assemble pinion housing over Bendix drive, and make sure intermediate bearing plate is tight against seat, with dowel pin in its proper place.

(10) Place armature and pinion housing in frame and field assembly, and aline pinion housing on dowel pin.

(11) Place thrust washer on commutator end of armature shaft. Install commutator end head on armature shaft and against frame, and install frame screws. Strike the frame a few sharp blows with a rawhide hammer as the screws are tightened.

(12) Connect brush leads to insulated brushes.

CHAPTER 4

ELECTRICAL GENERATING SYSTEM

Section I

GENERAL

86. DESCRIPTION (fig. 168).

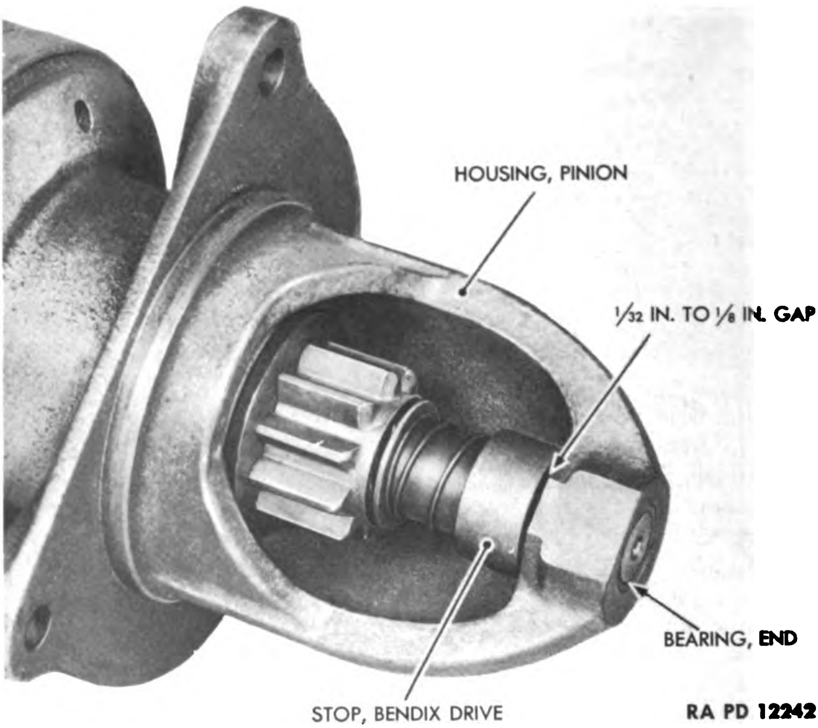
a. **General.** The generating system functions through the use of two electrical generators. The smaller of the two generators is a d-c, stationary field-type generator known as an exciter. Its function is to furnish excitation (direct current) for field windings of the other generator. The other generator is an a-c revolving field-type generator known as an alternator. Its function is to deliver the electrical output of the unit.

b. **Construction.** The generating system is made up of the exciter (d-c generator), the alternator (a-c generator), a rheostat on the exciter line, a load switch, an ammeter for finding the amperage of the current delivered, a voltmeter for determining the voltage, a meter switch to connect each of the phases of the circuit with the ammeter, two 125-volt light sockets, a toggle switch and a lamp-dimming rheostat to control them, two power receptacles, T-slot receptacles, and fuses.

c. **Functioning.** The engine, directly coupled to the alternator shaft, turns the alternator rotor, and through a V-belt the exciter armature, or by direct connection on the alternator shaft in the case of the Hobart Bros. Co. unit. The exciter supplies the alternator field current as required by the load. The exciter field rheostat may be used to maintain constant alternator output voltage under varying loads. The load switch completes or interrupts the load circuit from the alternator to the two power receptacles. Five T-slot receptacles and two lamp sockets are fed from the line ahead of the load switch. The lamps are controlled by a toggle switch, and the illumination given is controlled by a dimming rheostat.

87. TROUBLE SHOOTING.

a. **General.** Three things can go wrong with the coils and leads of a generator. These are an open circuit, a short circuit, and a ground.



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Section I
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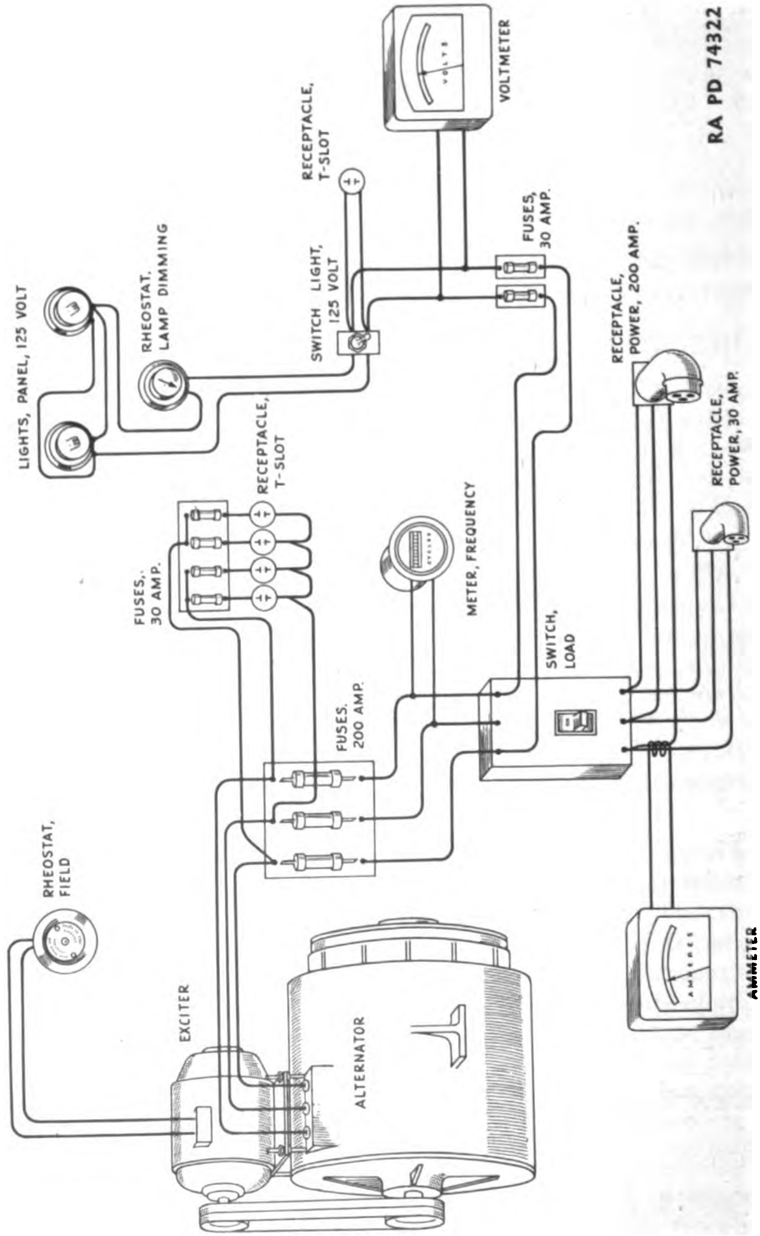

Figure 168 — Generating System

(1) OPEN CIRCUIT. An open circuit is caused by a break in a wire, or by the opening of a connection of two wires. This breaks the circuit because the current has no path to follow.

(2) SHORT CIRCUIT. A short circuit is caused by lack of insulation on two touching wires. This enables the current to take a "short cut" instead of traversing the route it is supposed to follow.

(3) GROUND. A ground is caused by lack of insulation on a wire or coil at point of contact with the framework of the generator. This allows the current to flow into the framework instead of following its proper course.

b. Test Lamp. Construct a test lamp by connecting in series, a lead, a battery, a lamp bulb, and another lead. Test operation of the test lamp by touching the points of the two leads together. The bulb should light.

c. Checking for an Open Circuit. Hold the point of one test lamp probe against the bare wire at one end of the coil or wire being tested. Place the point of the other probe against the bare wire at the other end of the coil or wire being tested. If the test lamp lights, a continuous circuit is indicated. If the test lamp fails to light, an open circuit exists in the coil or wire being tested.

d. Checking for a Short Circuit. Locating short circuits is more difficult than finding open circuits. No specific directions which will apply to all cases can be given. In general, loss of generator output and presence of excessive heat indicate a short circuit.

e. Checking for a Ground. Hold one probe of the test lamp against a bare lead to the coil or wire being tested. Touch other probe of test lamp against the frame of the generator. If the test lamp lights, a ground is present. If the lamp fails to light, absence of ground is indicated.

f. Trouble Shooting Chart.

(1) ARCING AT EXCITER BRUSHES.

Possible Cause	Possible Remedy
Dirt on commutator.	Clean commutator.
Worn brushes.	Replace brushes.
Brushes stuck in holders.	Remove, clean, and install brush holders and brushes.
Open circuit in armature coil in exciter.	Replace coil.
Open circuit in alternator lead to field rheostat.	Solder lead.

(2) ALTERNATOR FAILS TO GENERATE RATED AMPERES.

Unbalanced load on lines.	Balance load.
Defective wiring in circuit.	Replace or repair wiring.

Possible Cause	Possible Cause
Field rheostat incorrectly adjusted.	Adjust rheostat.
Dirt on exciter commutator.	Clean exciter commutator (par. 101).
Worn brushes on exciter.	Replace exciter brushes (par. 101).
Defective rotor.	Replace rotor (pars. 92 and 95).
Short circuit in revolving field coil.	Replace revolving field coil (par. 92).
Open circuit in revolving field coil.	Replace revolving field coil (par. 92).
Grounded revolving field coil.	Replace revolving field coil (par. 92).
Open circuit in field coil lead.	Solder field coil lead (par. 119).
Short circuit in field coil lead.	Replace field coil lead (par. 92).
Fuse burned out.	Replace fuse element.
Defective ammeter.	Replace ammeter.

(3) FAILS TO OPERATE AT PROPER FREQUENCY.

Engine speed too low.	Adjust engine speed (par. 50).
Engine speed too high.	Adjust engine speed (par. 50).

(4) ALTERNATOR DELIVERS NO VOLTAGE OR AMPERAGE.

Load switch off.	Put on load switch.
Dirt on commutator of exciter.	Clean commutator.
Exciter brushes stuck in holders.	Remove, clean, and install brush holder and brush (par. 101).
Worn exciter brushes.	Replace exciter brushes (par. 101).
Worn collector ring brushes.	Replace collector ring brushes (par. 95).
Open circuit in revolving field coil.	Replace revolving field coil (par. 92).
Open circuit in field coil lead.	Connect and solder field coil lead (par. 92).
Defective rotor.	Replace rotor (pars. 92 and 95).
Grounded revolving field coil.	Replace revolving field coil (par. 92).
Fuses blown out.	Replace fuse elements.
Open circuit in stator windings.	Replace body and stator (pars. 92 and 95).
Open circuit in wiring.	Test and repair or replace wiring.

(5) VOLTMETER SHOWS NO VOLTAGE.

Possible Cause	Possible Remedy
Defective voltmeter.	Replace voltmeter.
Fuses burned out.	Replace fuses.
Defective contacts in meter switch.	Repair contacts or replace meter switch.

(6) AMMETER REGISTERS TOO HIGH.

Defective ammeter.	Replace ammeter.
Improperly balanced load.	Balance load.
Unit overloaded.	Reduce load.

88. 200-AMPERE POWER RECEPTACLE (fig. 169).

a. **Description.** The 200-amp, three-pole power receptacle is the larger of the two power receptacles located on the left side of the unit. It is of gooseneck type, and is provided with a chained cover for protection when not in use.

b. **Removal.**

(1) Remove nuts and take off receptacle leads from the three studs at the bottom of the fuse panel.

(2) Take out stove bolts and nuts holding receptacle to side panel of housing, and remove receptacle. Chain, holding cover to housing, will come off with the removal of the lower left bolt.

c. **Inspection and Repair.**

(1) Check body and cover for cracks or stripped threads. Repair or replace defective parts.

(2) Remove shoe from nut by taking out four flat-head screws. Examine nut and shoe for cracks, and screws for stripped threads. Replace defective parts.

(3) Remove ring from body groove just inside rim, and pull out insulation, terminals, and plate. Examine all parts for cracks, chips, and breaks. Replace if defective. Examine soldered connections of terminals and cables. Resolder if loose.

d. **Disassembly.**

(1) Unscrew nut holding cover to body, and remove cover.

(2) Remove ring from body groove just inside rim, and pull out insulation, terminals with cables still connected, and plate.

(3) Play soldering torch on cable terminals, until the solder holding cables in terminals is loosened, then remove cables.

e. **Assembly.**

(1) Solder one of the three cables into the small cup at the back of each of the three terminals.

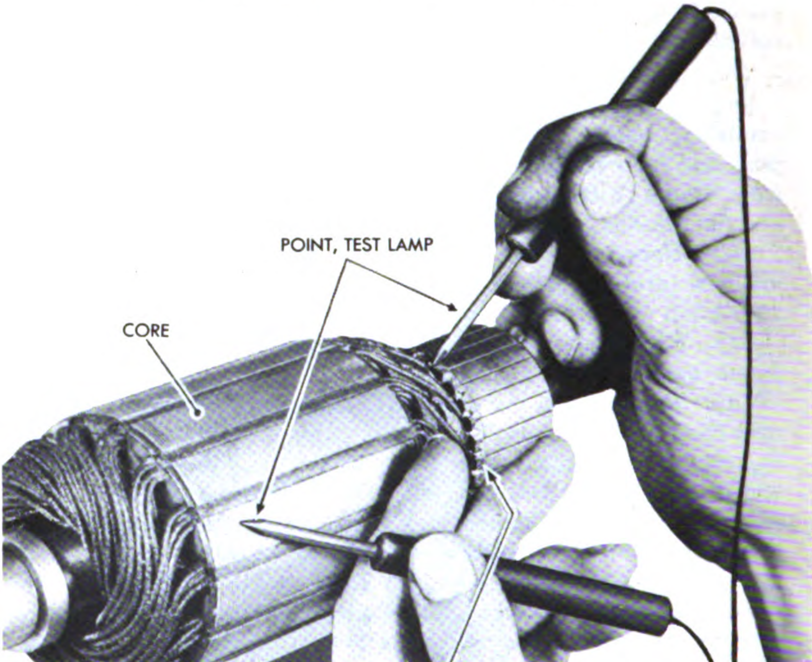

Figure 164 – Testing Armature for Ground

e. Commutator End Head.

(1) Clean commutator end head and all parts except brushes in SOLVENT, dry cleaning. Blow dry with compressed air.

(2) Inspect all parts for scoring, distortion, and breakage.

(3) If brushes are worn to less than half their original length, replace with new ones. Compare the old brush with a new one to determine the amount of wear.

(4) Fit armature shaft into bearing. If there is any perceptible side play, replace commutator end head.

85. ASSEMBLY.

a. Procedure.

(1) Install brush-holder spacing insulators, spring insulators, brush arms, brush springs, insulating bushings, and insulating washers in commutator head. Install brush holder post clips on posts.

(2) Place brushes and ground connectors in position in commutator head. Install brush lead ground screws. Install brush screws.

ENGINE AND ACCESSORIES

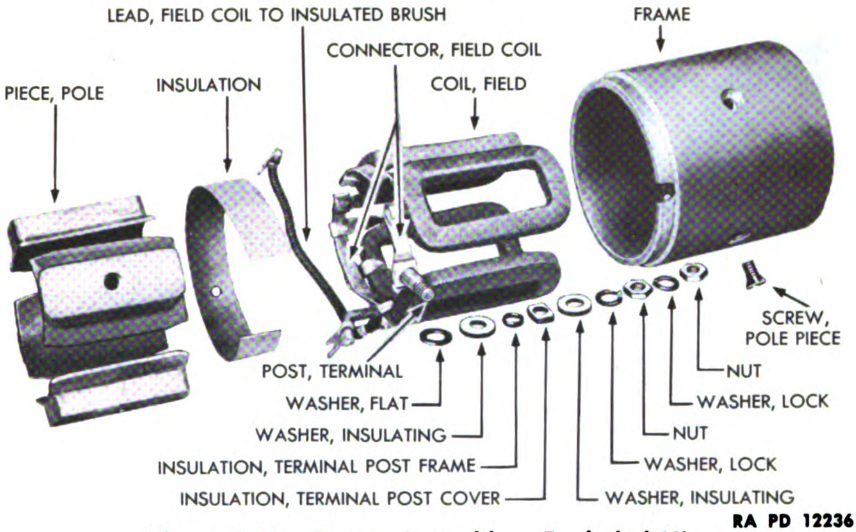

Figure 165 — Frame Assembly — Exploded View

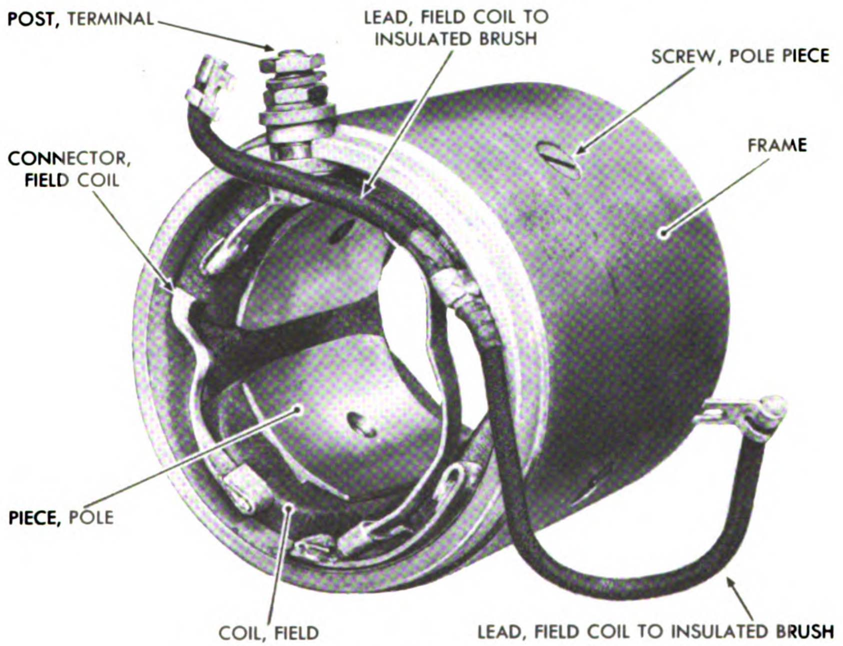

Figure 166 — Starting Motor Frame Assembly

(3) Soak all bearings in OIL, engine, SAE 10, and apply a light wipe of oil to armature shaft bearing seats.

(4) Assemble intermediate bearing plate on armature shaft.

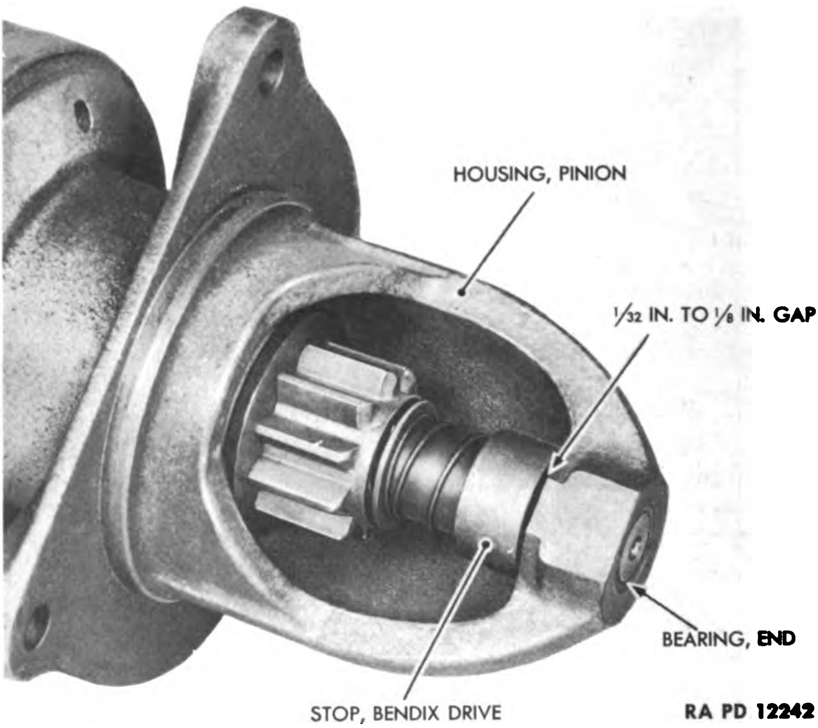

Figure 167 — Starting Motor Pinion Housing

(5) Install dowel pin in Bendix head, and Woodruff key in armature shaft.

(6) Press intermediate bearing plate and head on armature shaft.

(7) Install drive spring on armature, and then install pinion assembly.

(8) Install head spring screw and shaft spring screw, and tighten. Lock screws with special lock washers.

(9) Assemble pinion housing over Bendix drive, and make sure intermediate bearing plate is tight against seat, with dowel pin in its proper place.

(10) Place armature and pinion housing in frame and field assembly, and aline pinion housing on dowel pin.

(11) Place thrust washer on commutator end of armature shaft. Install commutator end head on armature shaft and against frame, and install frame screws. Strike the frame a few sharp blows with a rawhide hammer as the screws are tightened.

(12) Connect brush leads to insulated brushes.

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87. TROUBLE SHOOTING.

a. **General.** Three things can go wrong with the coils and leads of a generator. These are an open circuit, a short circuit, and a ground.

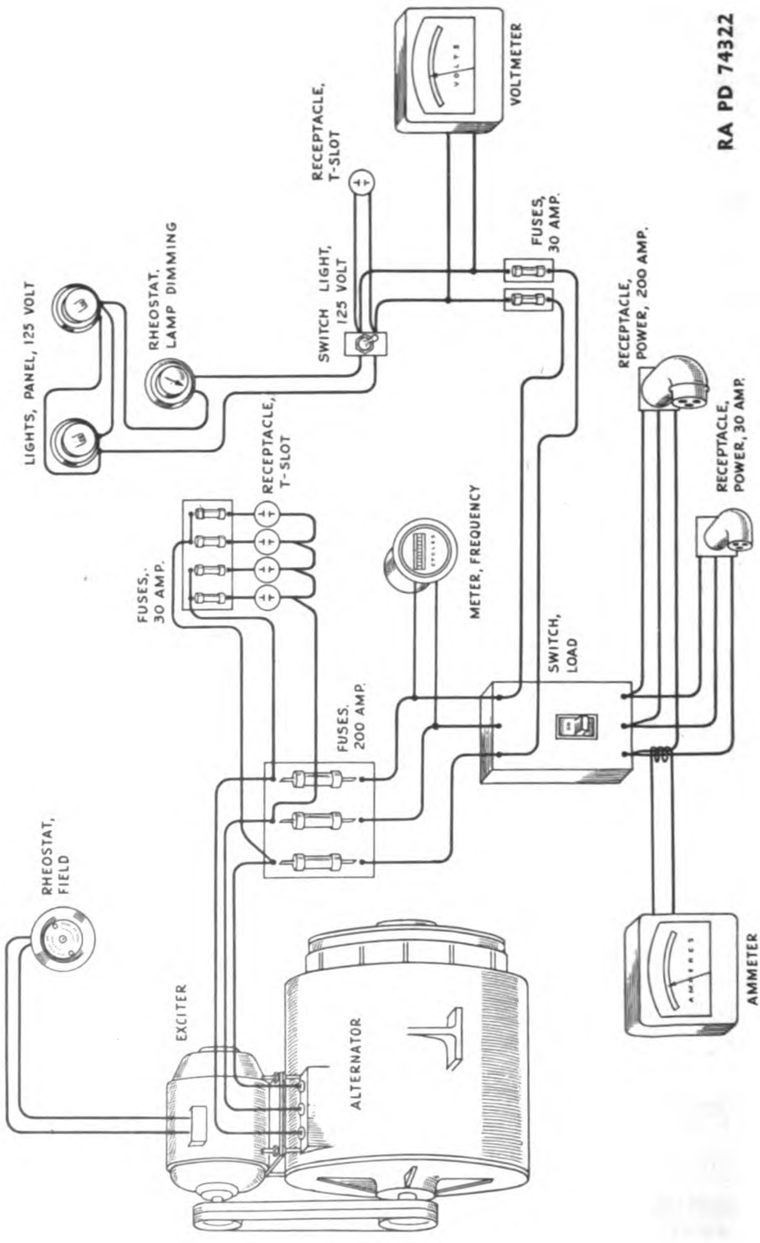

Figure 168 — Generating System

(1) Open Circuit. An open circuit is caused by a break in a wire, or by the opening of a connection of two wires. This breaks the circuit because the current has no path to follow.

(2) Short Circuit. A short circuit is caused by lack of insulation on two touching wires. This enables the current to take a "short cut" instead of traversing the route it is supposed to follow.

(3) Ground. A ground is caused by lack of insulation on a wire or coil at point of contact with the framework of the generator. This allows the current to flow into the framework instead of following its proper course.

b. **Test Lamp.** Construct a test lamp by connecting in series, a lead, a battery, a lamp bulb, and another lead. Test operation of the test lamp by touching the points of the two leads together. The bulb should light.

c. **Checking for an Open Circuit.** Hold the point of one test lamp probe against the bare wire at one end of the coil or wire being tested. Place the point of the other probe against the bare wire at the other end of the coil or wire being tested. If the test lamp lights, a continuous circuit is indicated. If the test lamp fails to light, an open circuit exists in the coil or wire being tested.

d. **Checking for a Short Circuit.** Locating short circuits is more difficult than finding open circuits. No specific directions which will apply to all cases can be given. In general, loss of generator output and presence of excessive heat indicate a short circuit.

e. **Checking for a Ground.** Hold one probe of the test lamp against a bare lead to the coil or wire being tested. Touch other probe of test lamp against the frame of the generator. If the test lamp lights, a ground is present. If the lamp fails to light, absence of ground is indicated.

f. **Trouble Shooting Chart.**

(1) Arcing at Exciter Brushes.

Possible Cause	Possible Remedy
Dirt on commutator.	Clean commutator.
Worn brushes.	Replace brushes.
Brushes stuck in holders.	Remove, clean, and install brush holders and brushes.
Open circuit in armature coil in exciter.	Replace coil.
Open circuit in alternator lead to field rheostat.	Solder lead.

(2) Alternator Fails to Generate Rated Amperes.

Unbalanced load on lines.	Balance load.
Defective wiring in circuit.	Replace or repair wiring.

Possible Cause	Possible Cause
Field rheostat incorrectly adjusted.	Adjust rheostat.
Dirt on exciter commutator.	Clean exciter commutator (par. 101).
Worn brushes on exciter.	Replace exciter brushes (par. 101).
Defective rotor.	Replace rotor (pars. 92 and 95).
Short circuit in revolving field coil.	Replace revolving field coil (par. 92).
Open circuit in revolving field coil.	Replace revolving field coil (par. 92).
Grounded revolving field coil.	Replace revolving field coil (par. 92).
Open circuit in field coil lead.	Solder field coil lead (par. 119).
Short circuit in field coil lead.	Replace field coil lead (par. 92).
Fuse burned out.	Replace fuse element.
Defective ammeter.	Replace ammeter.

(3) FAILS TO OPERATE AT PROPER FREQUENCY.

Engine speed too low.	Adjust engine speed (par. 50).
Engine speed too high.	Adjust engine speed (par. 50).

(4) ALTERNATOR DELIVERS NO VOLTAGE OR AMPERAGE.

Load switch off.	Put on load switch.
Dirt on commutator of exciter.	Clean commutator.
Exciter brushes stuck in holders.	Remove, clean, and install brush holder and brush (par. 101).
Worn exciter brushes.	Replace exciter brushes (par. 101).
Worn collector ring brushes.	Replace collector ring brushes (par. 95).
Open circuit in revolving field coil.	Replace revolving field coil (par. 92).
Open circuit in field coil lead.	Connect and solder field coil lead (par. 92).
Defective rotor.	Replace rotor (pars. 92 and 95).
Grounded revolving field coil.	Replace revolving field coil (par. 92).
Fuses blown out.	Replace fuse elements.
Open circuit in stator windings.	Replace body and stator (pars. 92 and 95).
Open circuit in wiring.	Test and repair or replace wiring.

(5) VOLTMETER SHOWS NO VOLTAGE.

Possible Cause	Possible Remedy
Defective voltmeter.	Replace voltmeter.
Fuses burned out.	Replace fuses.
Defective contacts in meter switch.	Repair contacts or replace meter switch.

(6) AMMETER REGISTERS TOO HIGH.

Defective ammeter.	Replace ammeter.
Improperly balanced load.	Balance load.
Unit overloaded.	Reduce load.

88. 200-AMPERE POWER RECEPTACLE (fig. 169).

a. **Description.** The 200-amp, three-pole power receptacle is the larger of the two power receptacles located on the left side of the unit. It is of gooseneck type, and is provided with a chained cover for protection when not in use.

b. **Removal.**

(1) Remove nuts and take off receptacle leads from the three studs at the bottom of the fuse panel.

(2) Take out stove bolts and nuts holding receptacle to side panel of housing, and remove receptacle. Chain, holding cover to housing, will come off with the removal of the lower left bolt.

c. **Inspection and Repair.**

(1) Check body and cover for cracks or stripped threads. Repair or replace defective parts.

(2) Remove shoe from nut by taking out four flat-head screws. Examine nut and shoe for cracks, and screws for stripped threads. Replace defective parts.

(3) Remove ring from body groove just inside rim, and pull out insulation, terminals, and plate. Examine all parts for cracks, chips, and breaks. Replace if defective. Examine soldered connections of terminals and cables. Resolder if loose.

d. **Disassembly.**

(1) Unscrew nut holding cover to body, and remove cover.

(2) Remove ring from body groove just inside rim, and pull out insulation, terminals with cables still connected, and plate.

(3) Play soldering torch on cable terminals, until the solder holding cables in terminals is loosened, then remove cables.

e. **Assembly.**

(1) Solder one of the three cables into the small cup at the back of each of the three terminals.

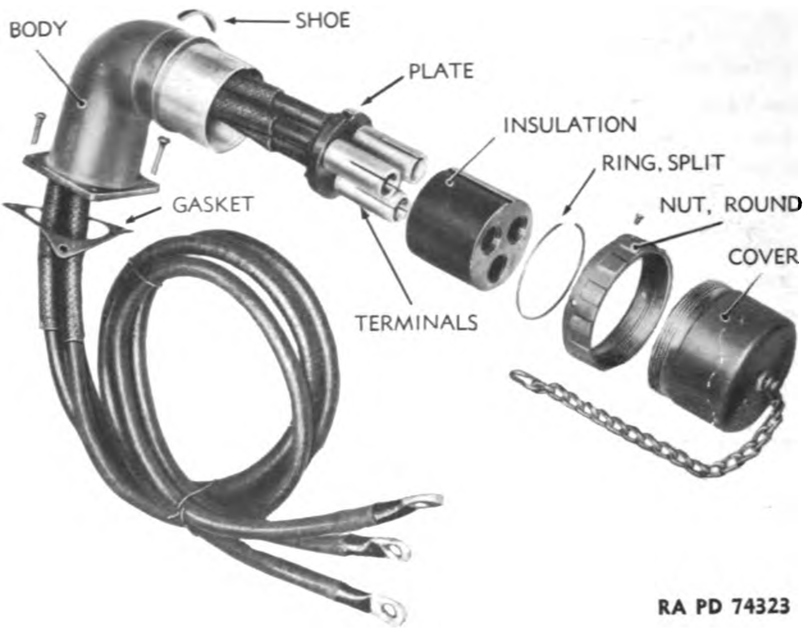

Figure 169 — 200-ampere Power Receptacle

(2) Push plate into terminal body, fitting rim groove to body indentation. Fit terminals into plate cover holes, wire end first, and draw wires out through gooseneck.

(3) Fit insulation into receptacle body, with groove running into body indentation. Secure with ring snapped into place just back of body rim.

(4) Put nut on body, and insert shoe, and fasten to nut.

f. Installation.

(1) Carry leads through hole in housing side panel, hold receptacle in position, secure with stove bolts and nuts. Under the lower left-hand bolt head, install the end link of the cap chain.

(2) Bring wires through iron collar back of receptacles, to fuse panel. Lead marked "A" goes to the right-hand stud. "B" lead attaches to the center stud. "C" lead attaches to the left stud. Secure leads with nuts.

89. 30-AMPERE POWER RECEPTACLE (fig. 170).

a. Description. The 30-amp, three-pole power receptacle is the smaller of the two-power receptacles located on the left side of the unit. It is of gooseneck type and is provided with a chained cap for protection, when not in use.

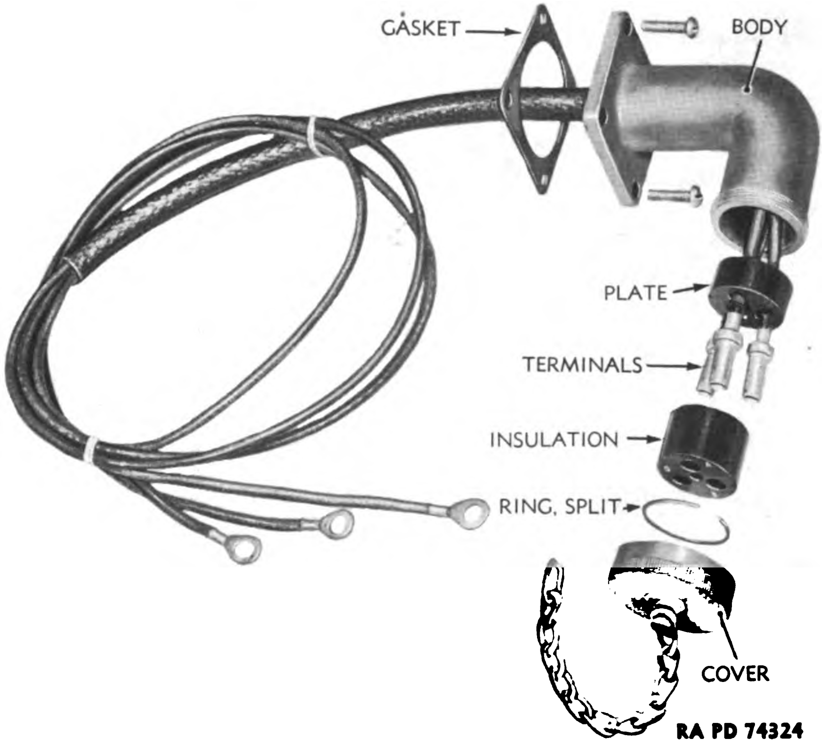

Figure 170 — 30-ampere Power Receptacle

b. Removal.

(1) Remove lock nuts and take off receptacle leads from the three studs on the fuse panel.

(2) Take out stove bolts and nuts holding receptacle to side panel of housing and remove receptacle. Chain, holding cap to housing, will come off with the removal of the lower left-hand bolt.

c. Inspection and Repairs.

(1) Check body and cover for cracks or stripped threads. Repair or replace any defective parts.

(2) Remove ring from body groove just inside rim, and pull out retainer terminals and insulation. Examine all parts for cracks, chips, or breaks. Replace defective parts. Examine soldered connections of terminals and cables. Resolder if loose.

d. Disassembly.

(1) Unscrew cover. Pry ring out of groove just back of body rim, remove ring and retainer behind it.

(2) Pull terminals and wires out of receptacle, then shake or pull out insulation block.

(3) Play soldering torch on each terminal until solder is melted and wire comes free.

e. **Assembly.**

(1) Solder one of the three cables into the small cup at the back of each of the three terminals.

(2) Push plate into terminal body, fitting rim groove to body indentation. Fit terminals into plate holes, wire end first, and draw wires out through gooseneck.

(3) Fit insulation around terminals, and secure in place by installing ring just back of body rim.

f. **Installation.**

(1) Carry leads through hole in housing side panel, hold receptacle in position, secure with stove bolts and nuts. Under the lower left-hand bolt head, install the end link of the cover chain.

(2) Bring wires through iron collar back of receptacle, through open clamp on side of alternator and the clip on the end of the alternator to fuse panel. Lead marked "A" goes to the right-hand stud. "B" lead attaches to the center stud. "C" lead attaches to the left stud. Secure leads with lock nuts.

Section II

ALTERNATOR

90. DESCRIPTION (fig. 171).

a. The alternator is an electric a-c generator connected to the engine by means of a flexible coupling. It is a semiprotected type and is self-ventilated. The rated output is 35-kva, 28-kw (80% power factor) 3-phase, 60-cycles, 125-v. The alternator weighs 420 pounds.

b. The alternator, in combination with the exciter, takes the mechanical energy of the engine and transforms it into electrical

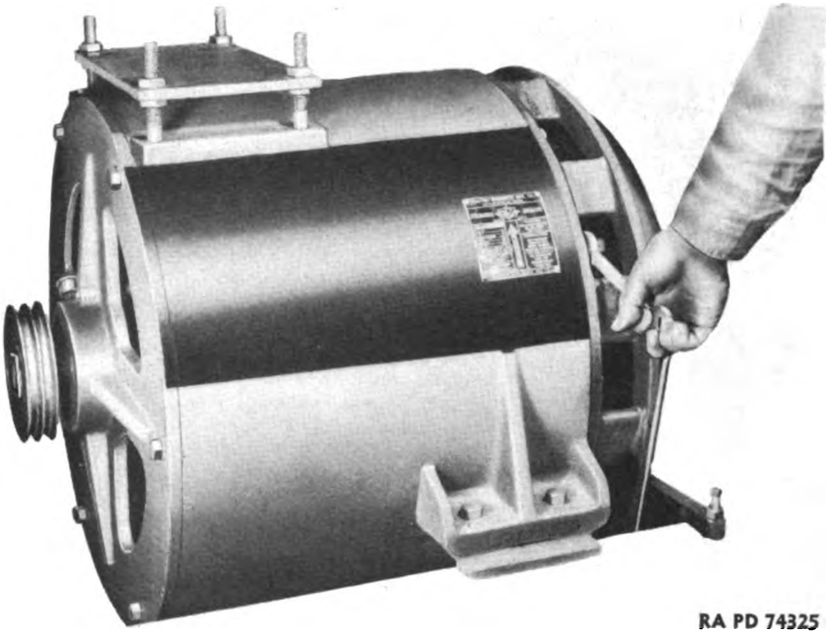

Figure 171 — Alternator — Exciter Removed

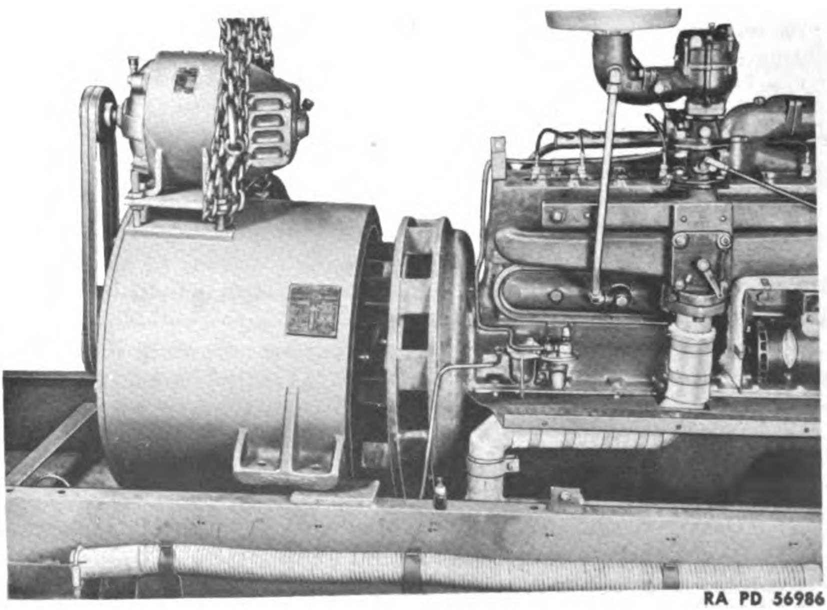

Figure 172 — Removing Alternator from Engine

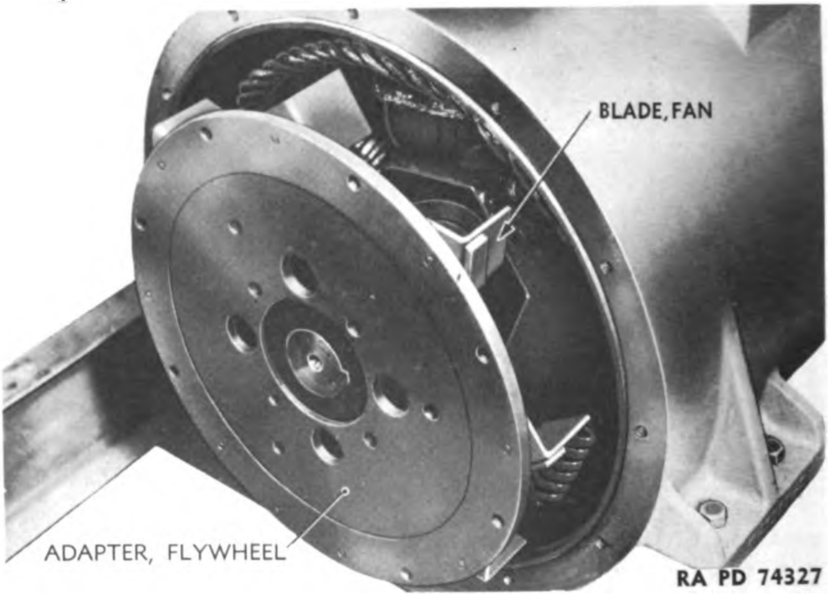

Figure 173 — Coupling End of Alternator, I.D.E. Co. Unit

energy by magnetic induction. When driven at its rated speed, the alternator, with its field energized by the exciter, produces a voltage at its terminals equivalent to that provided by the usual 125-volt lighting circuit. This voltage can be varied over a range of 90 to 150 volts by the use of the field rheostat.

91. REMOVAL.

a. All Units Except H. B. Co.

(1) Remove housing (par. 11).

(2) Remove expanded metal guard on bell housing.

(3) Take out the eight bolts attaching bell housing to alternator housing (fig. 19). Remove wires tying flywheel coupling bolts together. Remove castellated nuts from these bolts.

(4) Remove nuts from alternator hold-down screws in flange at each side of alternator. Engage hoist chains with exciter support bracket on top of alternator (fig. 172). Bring alternator back until it is clear of adapter ring, then lift alternator up and off the frame. Move to one side and lower to the floor.

b. H. B. Co. Unit (fig. 174).

(1) Unscrew nuts connecting leads to battery posts.

(2) Trace alternator main leads from alternator to control panel, remove nuts and lock washers securing leads to panel, and remove. Trace remaining alternator leads to fuse terminals, remove nuts and lock washers securing leads to terminals, and remove leads.

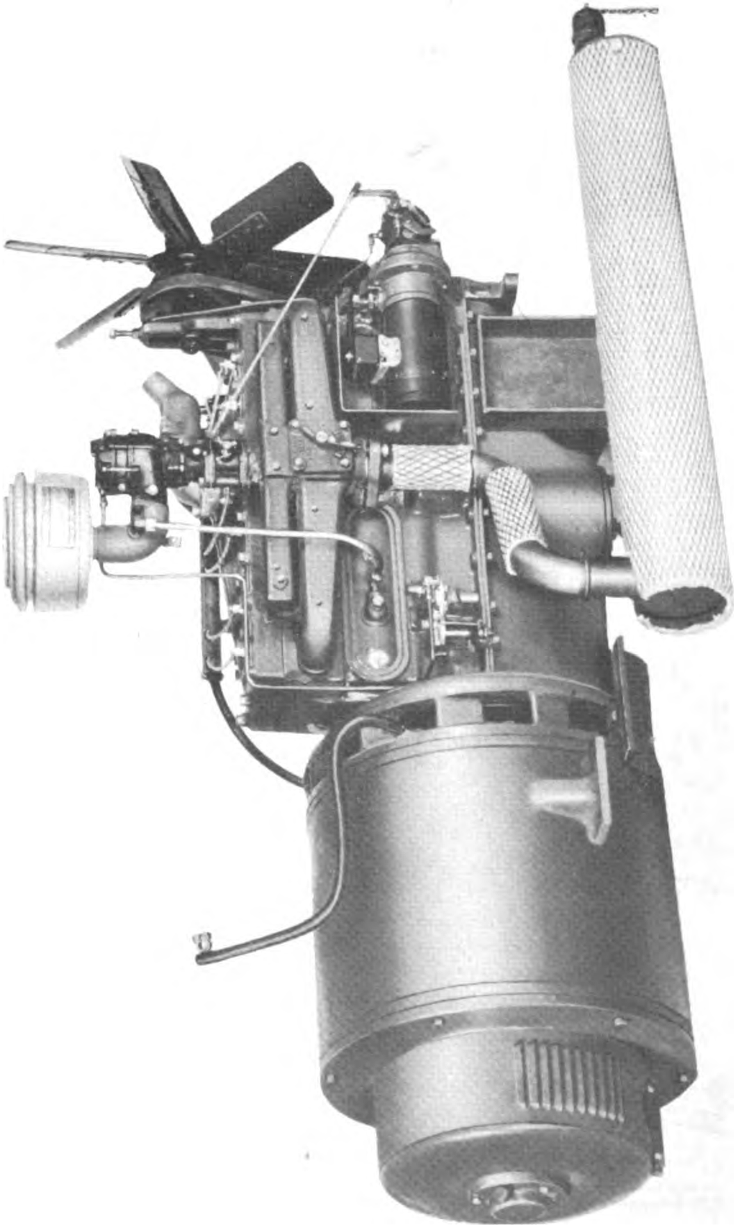

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Figure 174 — Alternator and Exciter with Engine, H. B. Co. Unit

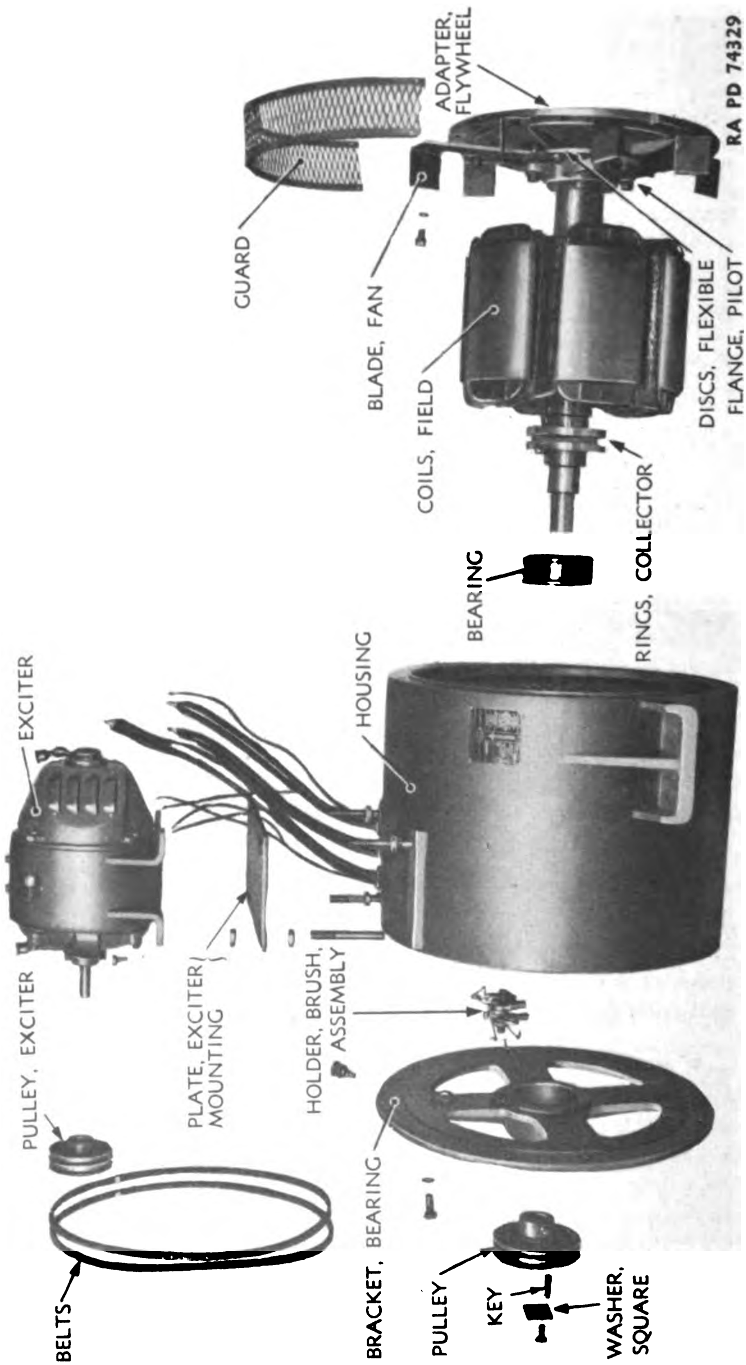
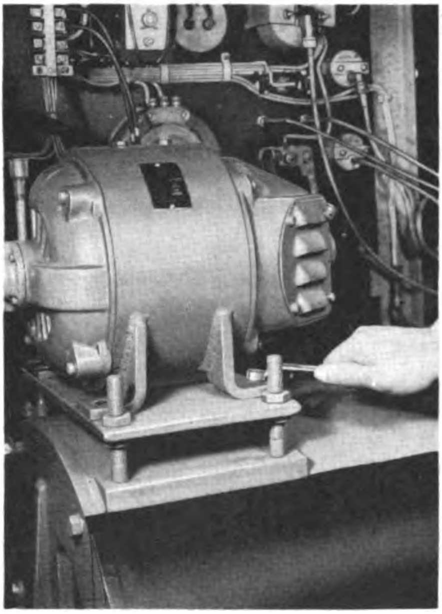


Figure 175 — Alternator — Exploded View



RA PD 56992

Figure 176 — Removing Exciter from Alternator

(3) Trace exciter leads to terminal block, take out connecting screws and lock washers, and remove leads.

(4) Remove nut and lock washer attaching brake receptacle housing rear plate. Remove nut and lock washer attaching lead, and remove lead.

(5) At starter button on instrument panel, remove nut and lock washer holding starting motor cable to panel, and remove cable.

(6) Loosen tachometer cable housing and disconnect tachometer lead.

(7) Trace lead from ignition coil to terminal block, unscrew connecting screw, and remove lead.

(8) Disconnect oil line flare tube fitting at gage and in oil filter base, and remove line.

(9) Trace heat indicator line from instrument panel to engine block, and disconnect bulb at end of line.

(10) Loosen clamping screw holding throttle and choke leads to carburetor. Loosen bolt through support bracket at top of engine, and remove leads from bracket.

(11) Open draincock in radiator outlet pipe. This will drain engine, radiator, and water lines.

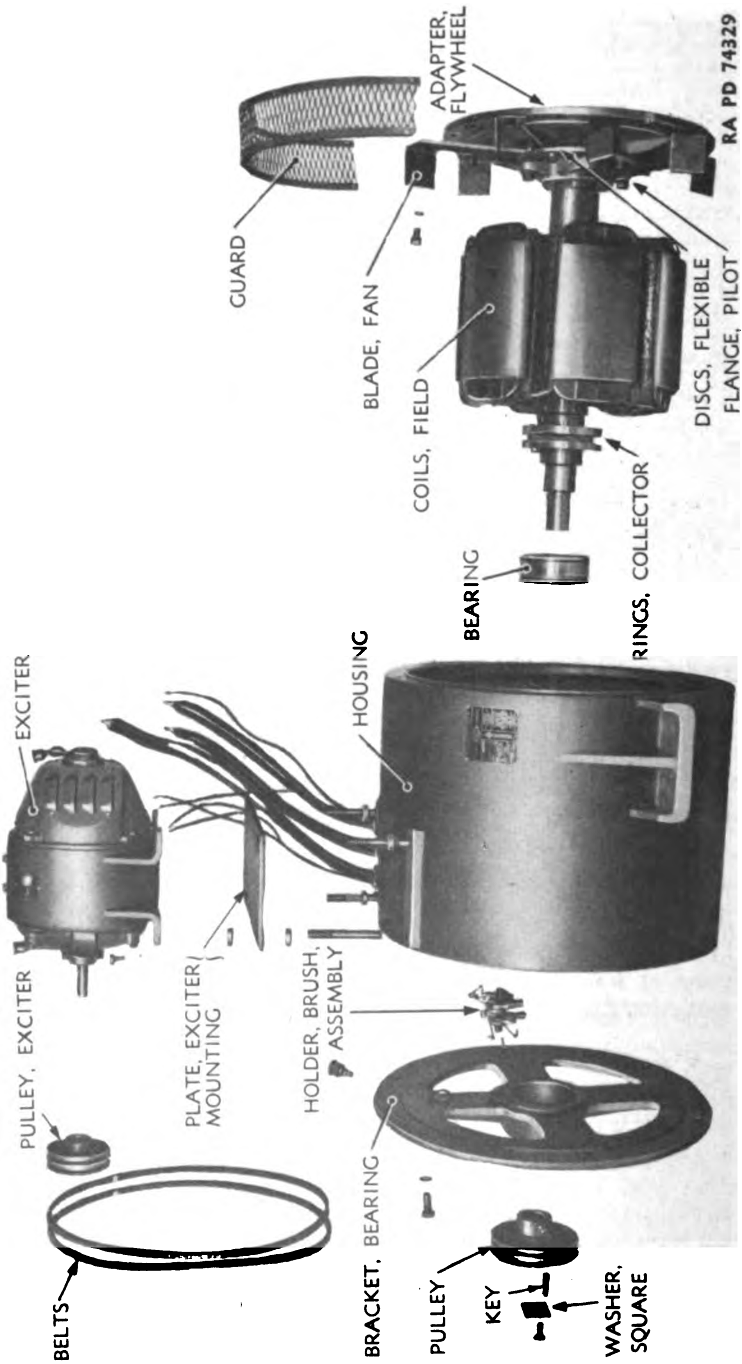
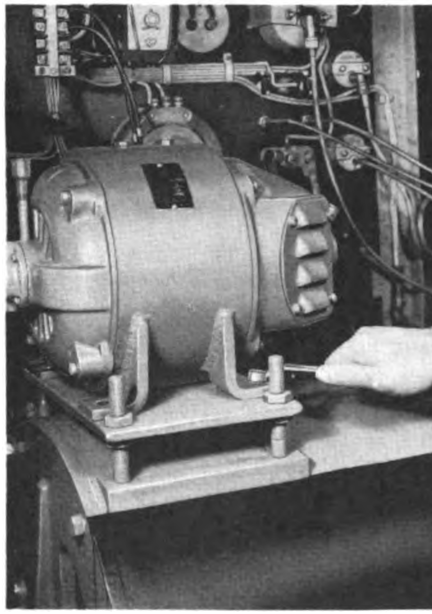


Figure 175 — Alternator — Exploded View



RA PD 56992

Figure 176 — Removing Exciter from Alternator

(3) Trace exciter leads to terminal block, take out connecting screws and lock washers, and remove leads.

(4) Remove nut and lock washer attaching brake receptacle housing rear plate. Remove nut and lock washer attaching lead, and remove lead.

(5) At starter button on instrument panel, remove nut and lock washer holding starting motor cable to panel, and remove cable.

(6) Loosen tachometer cable housing and disconnect tachometer lead.

(7) Trace lead from ignition coil to terminal block, unscrew connecting screw, and remove lead.

(8) Disconnect oil line flare tube fitting at gage and in oil filter base, and remove line.

(9) Trace heat indicator line from instrument panel to engine block, and disconnect bulb at end of line.

(10) Loosen clamping screw holding throttle and choke leads to carburetor. Loosen bolt through support bracket at top of engine, and remove leads from bracket.

(11) Open draincock in radiator outlet pipe. This will drain engine, radiator, and water lines.

(12) Loosen metal straps binding two hose sections in upper radiator water line and one hose section in lower radiator line by loosening bolts. Pull off hose.

(13) At point where flexible radiator overflow pipe enters compression fitting below draincock, remove pipe.

(14) Remove cap screws and lock washers attaching fan bracket to engine.

(15) Close shut-off cock on fuel line under fuel tank (fig. 83). Uncouple nut on engine side of shut-off cock, and remove line.

(16) Loosen manifold companion flange cap screws. Loosen manifold flange retaining screw. Remove exhaust pipe from manifold flanges.

(17) Remove nuts and lock washers from alternator hold-down screws in alternator flanges. Remove engine support cap screws, lock washers, and nuts.

(18) Block up and support engine and alternator to a level slightly above frame mounting level.

(19) Fix hoist chain hooks to the four lifting lugs on the frame. Carry frame forward to take alternator support flange bracket away from generator mounting flanges. Take out cap screws and lock washers holding flange bracket to frame, and remove bracket. Hoist frame and housing up, over, and down to one side.

(20) Take out cap screws and lock washers connecting engine flywheel housing to generator frame. Remove cap screws and lock washers attaching fan and coupling to flywheel.

(21) Adjust hoist chains about alternator. Bring alternator forward and away from engine. Be sure alternator is clear of engine before lifting.

92. DISASSEMBLY.

a. All Units Except H. B. Co. (fig. 175).

(1) Remove belts connecting exciter and alternator. Take out cap screws holding exciter to adjustable plate on top of alternator, and remove exciter (fig. 176).

(2) Lift springs from commutator brushes, and remove brushes from holders. Loosen screws holding leads, and remove leads. Loosen lock nut on stud securing brush-holder assemblies to bearing bracket, and remove stud with brush holders in place.

(3) Clip off edges of punch holes holding square washer tight against the screw in the alternator shaft. Remove screw (fig. 177). Take off pulley (fig. 178).

(4) Take out cap screws holding bearing bracket to alternator housing. Remove key from shaft, and remove bracket (fig. 179).

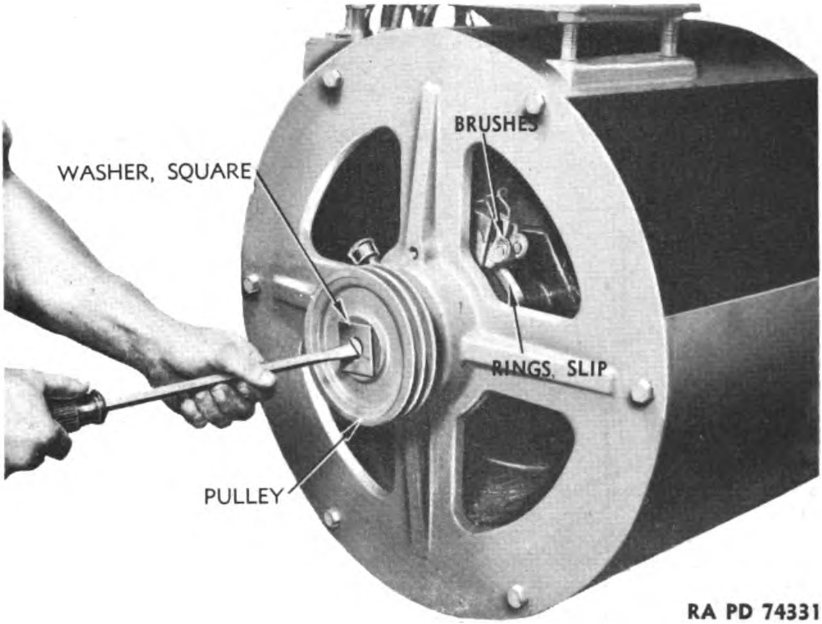


Figure 177 — Removing Alternator Shaft and Screw

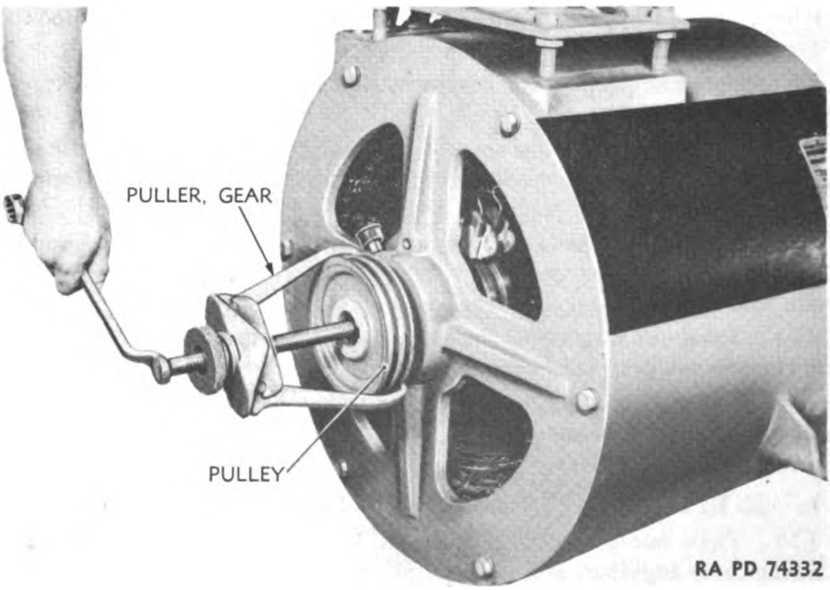


Figure 178 — Alternator Pulley Removal

(12) Loosen metal straps binding two hose sections in upper radiator water line and one hose section in lower radiator line by loosening bolts. Pull off hose.

(13) At point where flexible radiator overflow pipe enters compression fitting below draincock, remove pipe.

(14) Remove cap screws and lock washers attaching fan bracket to engine.

(15) Close shut-off cock on fuel line under fuel tank (fig. 83). Uncouple nut on engine side of shut-off cock, and remove line.

(16) Loosen manifold companion flange cap screws. Loosen manifold flange retaining screw. Remove exhaust pipe from manifold flanges.

(17) Remove nuts and lock washers from alternator hold-down screws in alternator flanges. Remove engine support cap screws, lock washers, and nuts.

(18) Block up and support engine and alternator to a level slightly above frame mounting level.

(19) Fix hoist chain hooks to the four lifting lugs on the frame. Carry frame forward to take alternator support flange bracket away from generator mounting flanges. Take out cap screws and lock washers holding flange bracket to frame, and remove bracket. Hoist frame and housing up, over, and down to one side.

(20) Take out cap screws and lock washers connecting engine flywheel housing to generator frame. Remove cap screws and lock washers attaching fan and coupling to flywheel.

(21) Adjust hoist chains about alternator. Bring alternator forward and away from engine. Be sure alternator is clear of engine before lifting.

92. DISASSEMBLY.

a. All Units Except H. B. Co. (fig. 175).

(1) Remove belts connecting exciter and alternator. Take out cap screws holding exciter to adjustable plate on top of alternator, and remove exciter (fig. 176).

(2) Lift springs from commutator brushes, and remove brushes from holders. Loosen screws holding leads, and remove leads. Loosen lock nut on stud securing brush-holder assemblies to bearing bracket, and remove stud with brush holders in place.

(3) Clip off edges of punch holes holding square washer tight against the screw in the alternator shaft. Remove screw (fig. 177). Take off pulley (fig. 178).

(4) Take out cap screws holding bearing bracket to alternator housing. Remove key from shaft, and remove bracket (fig. 179).

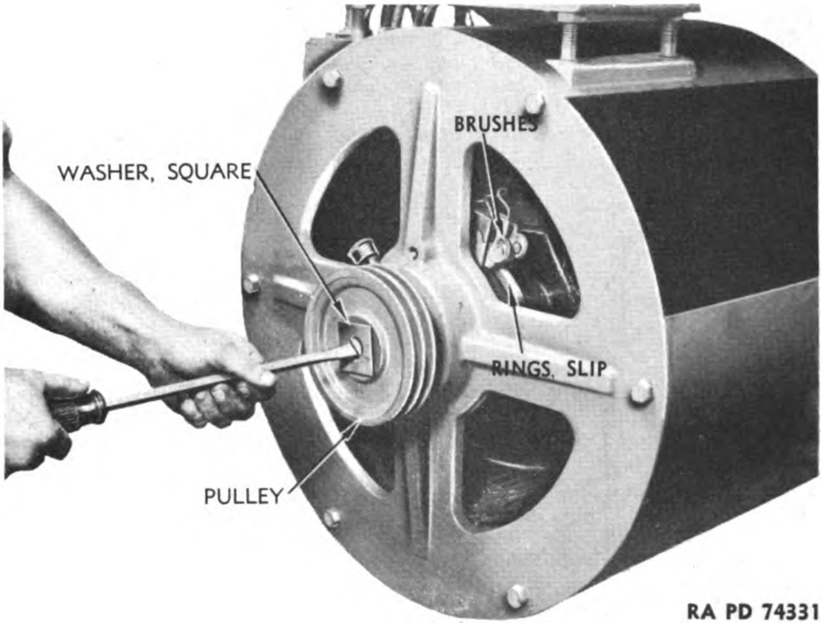


Figure 177 — Removing Alternator Shaft and Screw

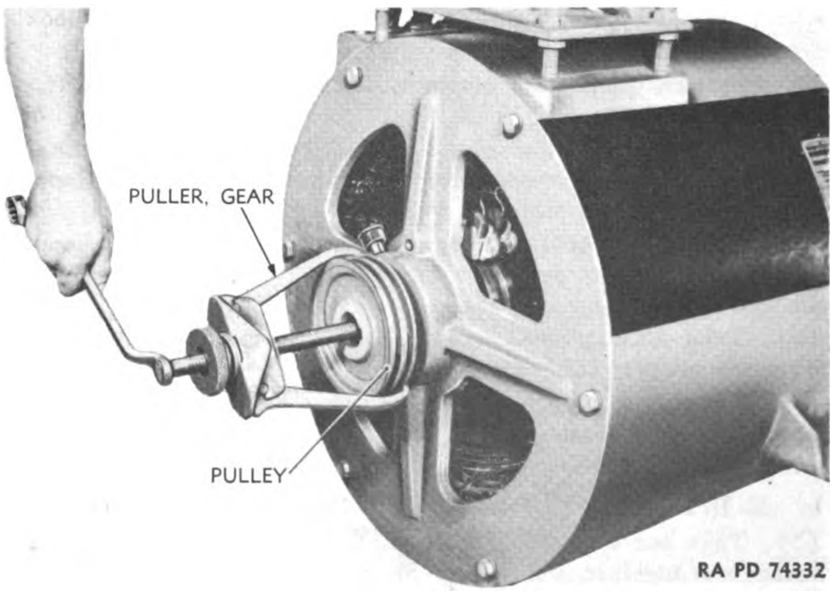


Figure 178 — Alternator Pulley Removal

(12) Loosen metal straps binding two hose sections in upper radiator water line and one hose section in lower radiator line by loosening bolts. Pull off hose.

(13) At point where flexible radiator overflow pipe enters compression fitting below draincock, remove pipe.

(14) Remove cap screws and lock washers attaching fan bracket to engine.

(15) Close shut-off cock on fuel line under fuel tank (fig. 83). Uncouple nut on engine side of shut-off cock, and remove line.

(16) Loosen manifold companion flange cap screws. Loosen manifold flange retaining screw. Remove exhaust pipe from manifold flanges.

(17) Remove nuts and lock washers from alternator hold-down screws in alternator flanges. Remove engine support cap screws, lock washers, and nuts.

(18) Block up and support engine and alternator to a level slightly above frame mounting level.

(19) Fix hoist chain hooks to the four lifting lugs on the frame. Carry frame forward to take alternator support flange bracket away from generator mounting flanges. Take out cap screws and lock washers holding flange bracket to frame, and remove bracket. Hoist frame and housing up, over, and down to one side.

(20) Take out cap screws and lock washers connecting engine flywheel housing to generator frame. Remove cap screws and lock washers attaching fan and coupling to flywheel.

(21) Adjust hoist chains about alternator. Bring alternator forward and away from engine. Be sure alternator is clear of engine before lifting.

92. DISASSEMBLY.

a. All Units Except H. B. Co. (fig. 175).

(1) Remove belts connecting exciter and alternator. Take out cap screws holding exciter to adjustable plate on top of alternator, and remove exciter (fig. 176).

(2) Lift springs from commutator brushes, and remove brushes from holders. Loosen screws holding leads, and remove leads. Loosen lock nut on stud securing brush-holder assemblies to bearing bracket, and remove stud with brush holders in place.

(3) Clip off edges of punch holes holding square washer tight against the screw in the alternator shaft. Remove screw (fig. 177). Take off pulley (fig. 178).

(4) Take out cap screws holding bearing bracket to alternator housing. Remove key from shaft, and remove bracket (fig. 179).

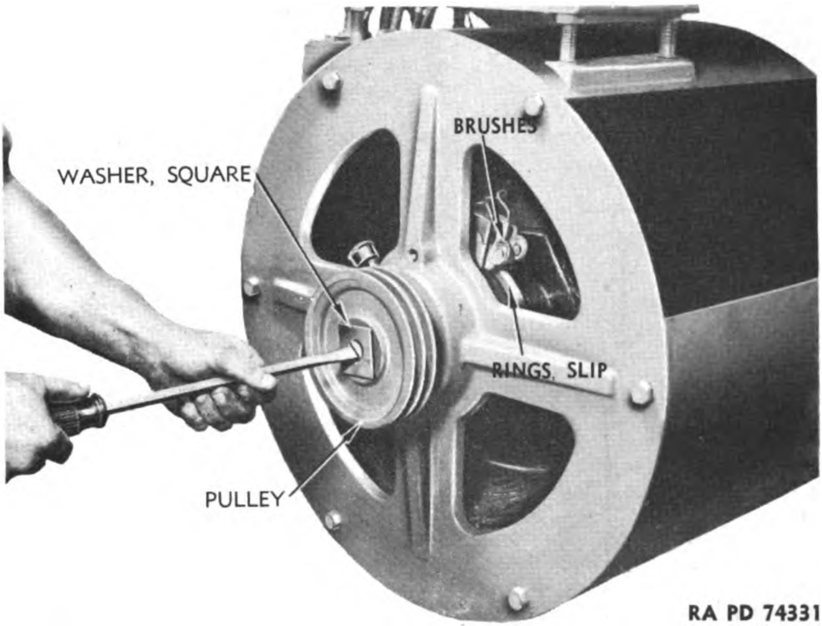


Figure 177 — Removing Alternator Shaft and Screw

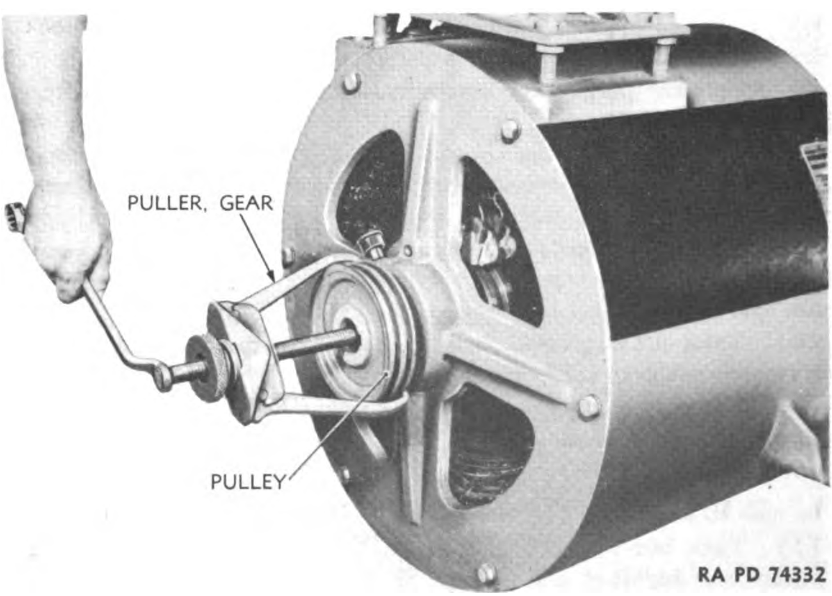


Figure 178 — Alternator Pulley Removal

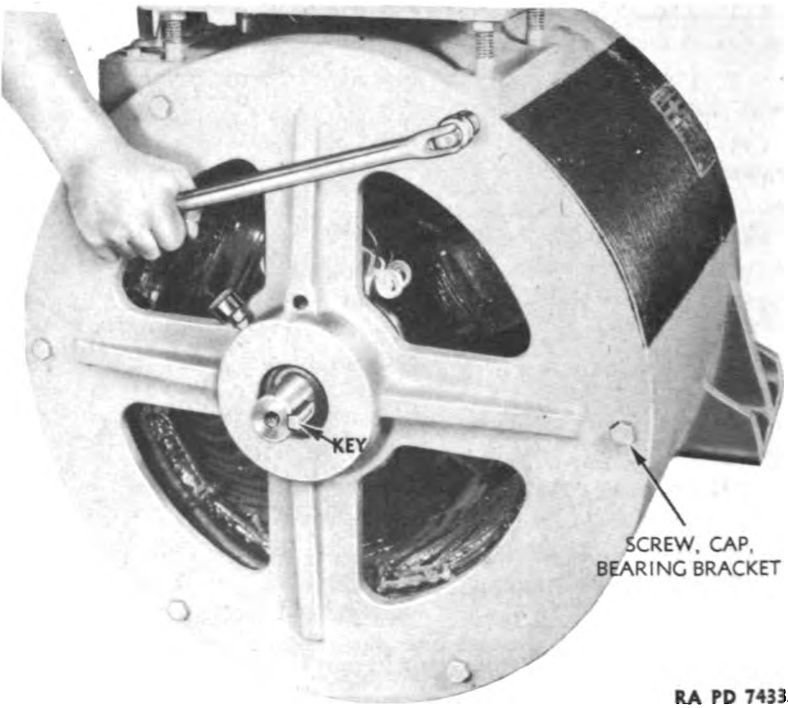


Figure 179 — Alternator Bearing Bracket Removal

(5) Pull complete rotor assembly from alternator housing (fig. 180) from fan plate side.

(6) Take bearing from rotor shaft *being particularly careful to apply gear puller pressure only against the inner race* (fig. 181). Bearing may be seriously damaged if pressure is applied to the outer race.

(7) Take out socket-head set screws through collector ring flange (fig. 182). Remove screws holding collector rings together, remove leads, and remove rings (fig. 183).

(8) Take out nuts holding flywheel adapter to the flexible disks, and remove adapter (fig. 184).

(9) Take nuts from cap screws holding flexible disks to pilot flange, and remove disks (fig. 185).

(10) Press pilot flange from shaft (fig. 186).

b. H. B. Co. Units (fig. 187).

(1) Take out screws and nuts holding ends of exciter bearing bracket cover together, and remove cover and gasket.

(2) Take out three cap screws, and remove armature bearing cap and gasket (fig. 188).

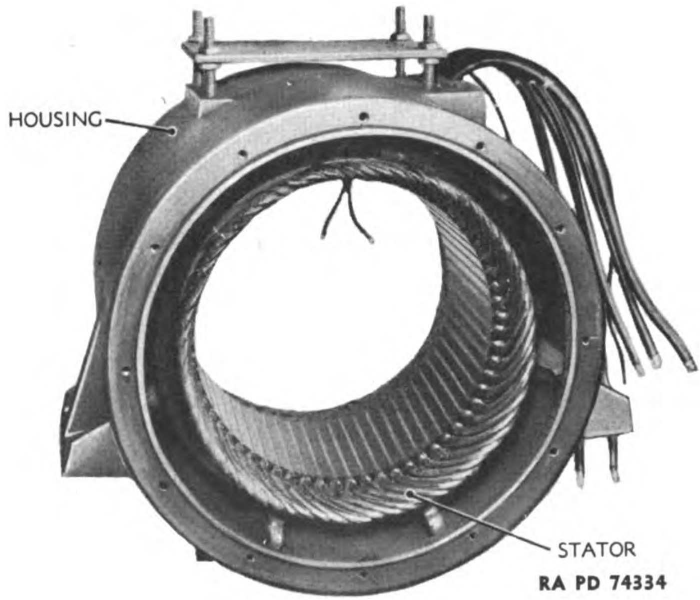


Figure 180 — Alternator Housing — Rotor Removed

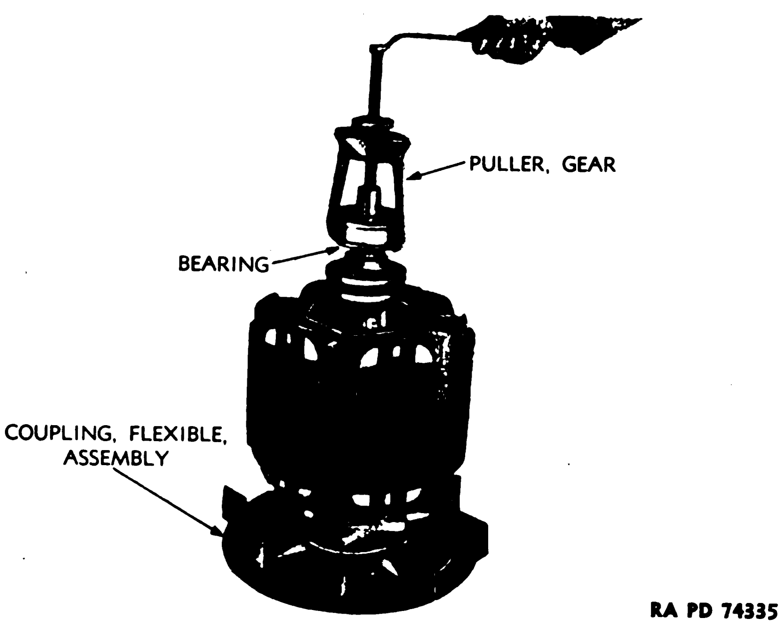


Figure 181 — Alternator Bearing Removal

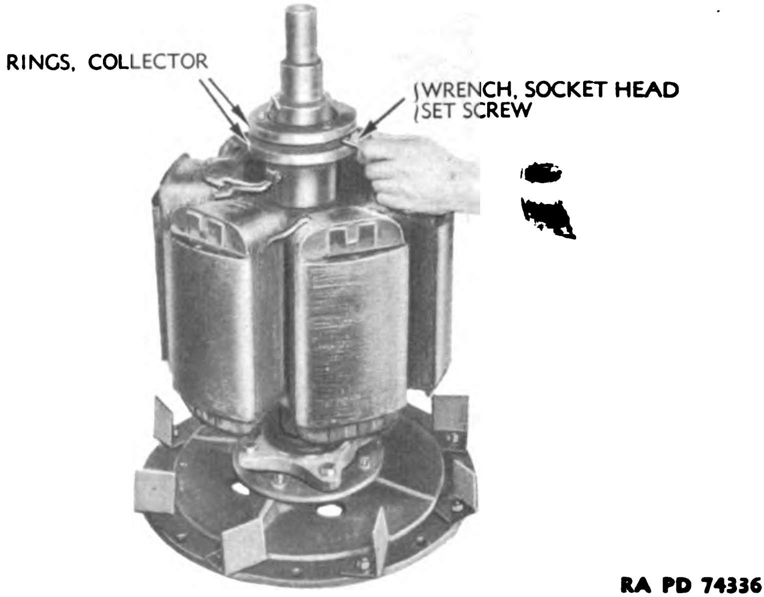


Figure 182 — Removing Collector Ring Flange Screws

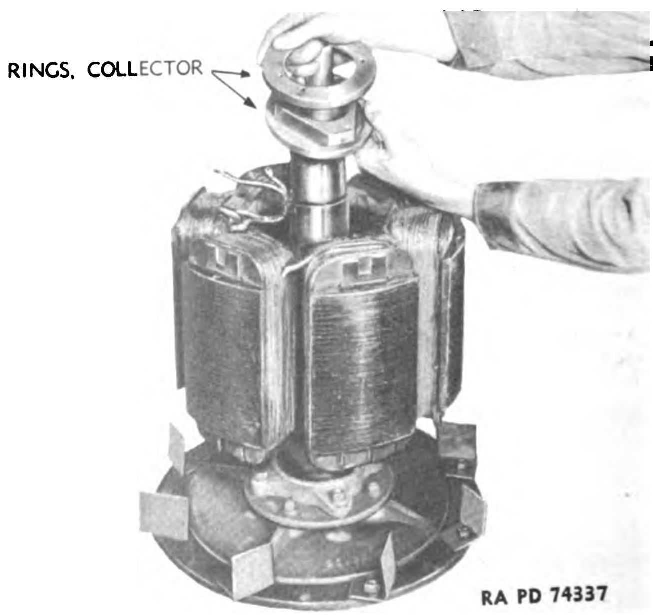


Figure 183 — Collector Ring Removal

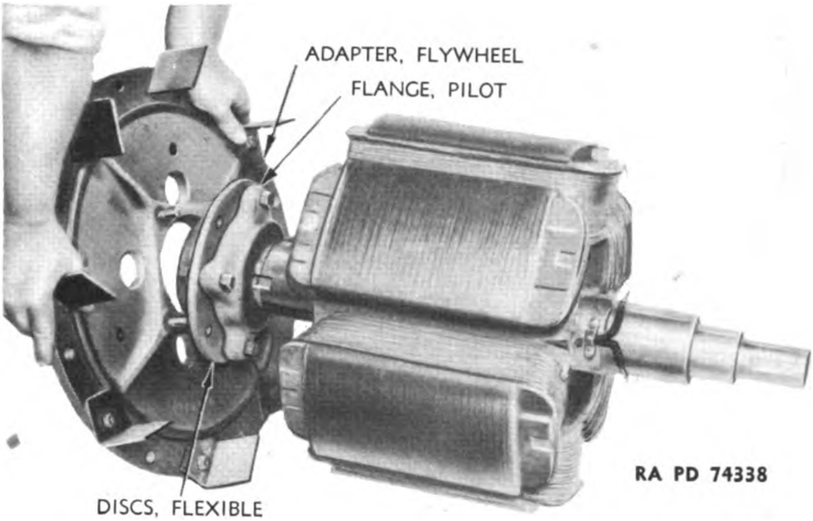


Figure 184 — Flexible Coupling Flywheel Adapter Removal

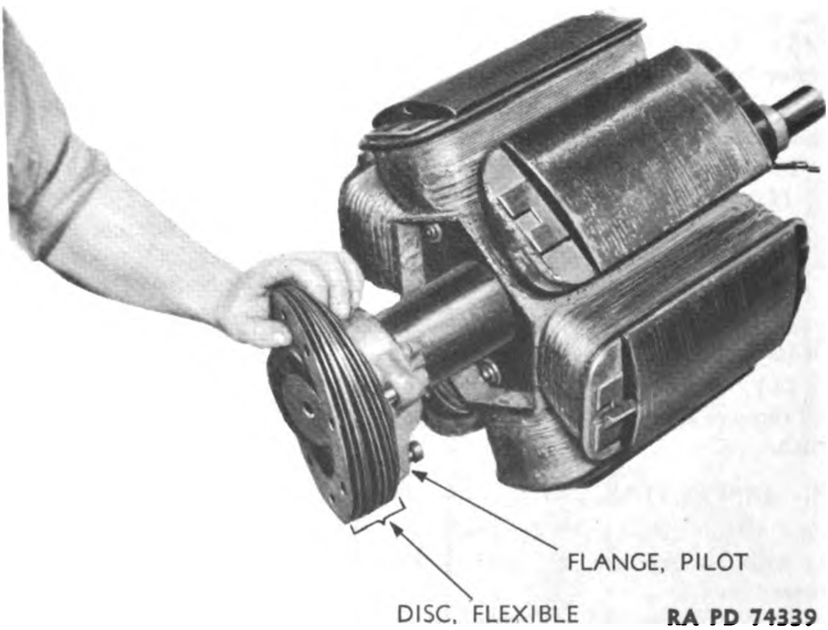


Figure 185 — Removing Coupling Flexible Disks

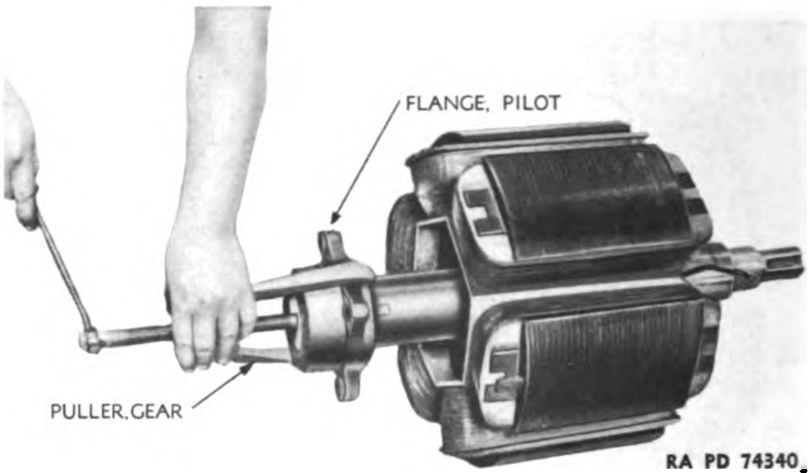


Figure 186 — Coupling Pilot Flange Removal

(3) Take out cap screws holding exciter bearing bracket to stator housing and remove bearing bracket (fig. 189).

(4) Take out cap screw attaching pole pieces to exciter field coil ring, and remove pole pieces and field coils (fig. 190).

(5) Disconnect leads. Loosen retaining screws holding rings to exciter bearing bracket, and remove brush holding rings (fig. 191).

(6) Take nut from end of shaft. Remove bearing. Take off grease retainer.

(7) Take out stator assembly and fan from coupling side of housing (fig. 192).

(8) Take out nuts holding flywheel adapter to the flexible disks, and remove adapter.

(9) Take nuts from cap screws holding flexible disks to pilot flange, and remove disks.

(10) Press pilot flange from shaft.

(11) Take out screws holding brush-holder assemblies together, and remove bushing, tension arm, spring, adjustable washer plate, and brush.

93. INSPECTION.

a. Clean metal parts by washing in SOLVENT, dry-cleaning, and dry with compressed air. Blow dirt from coils and windings with compressed air.

b. **Inspect Rotor Assembly.**

(1) Test revolving field coils for an open circuit by placing probes of a test lamp on the two slip rings. If lamp lights, no open

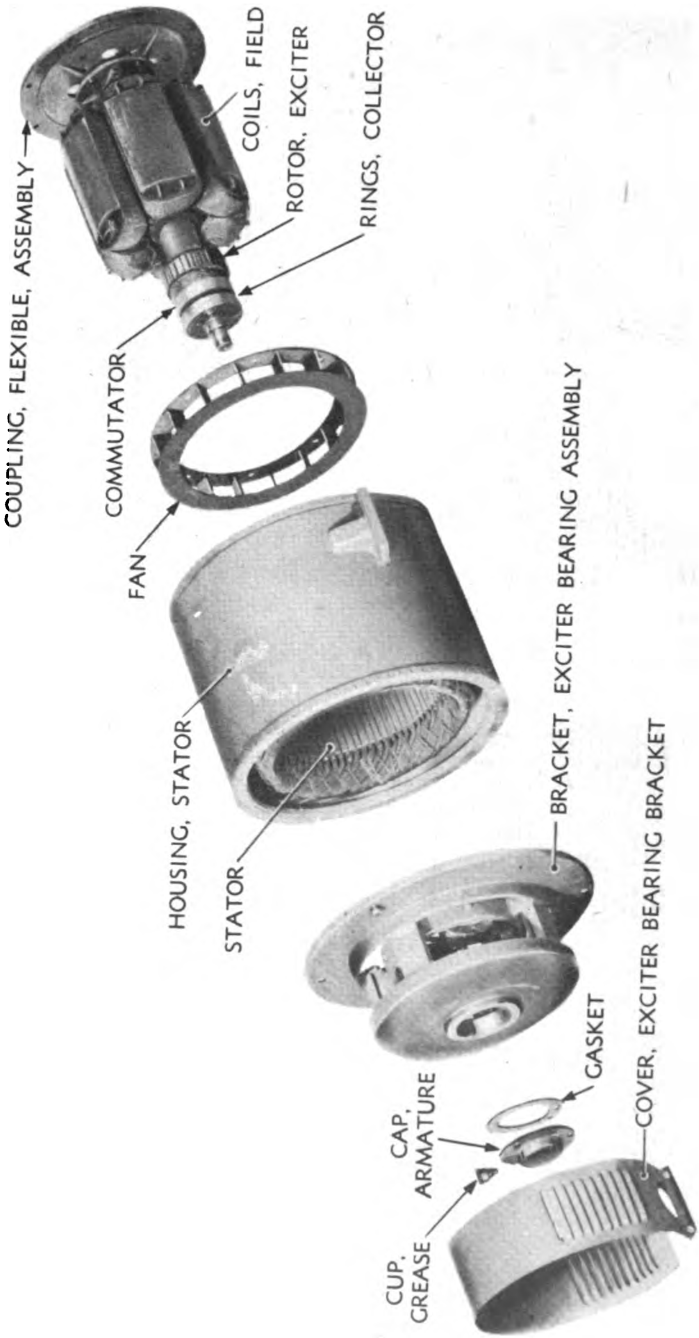


Figure 187 — Alternator and Exciter (H. B. Co. Unit) — Exploded View

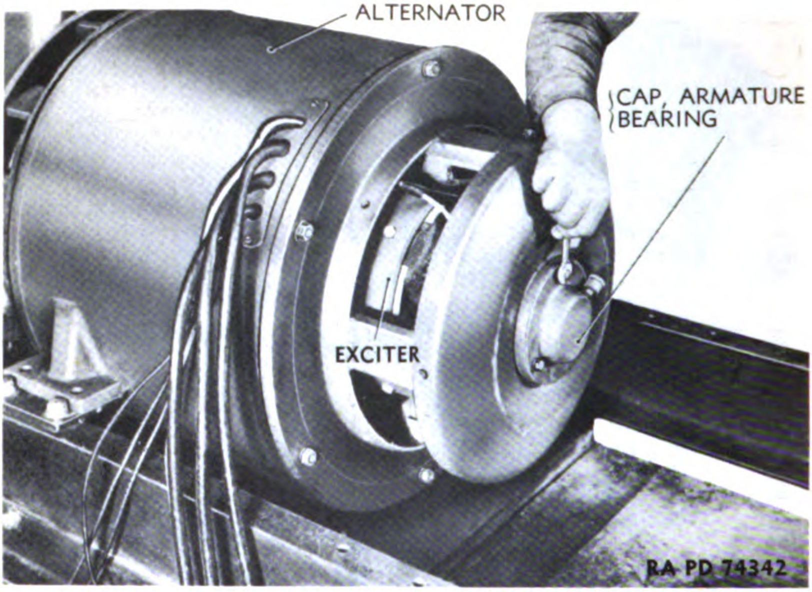


Figure 188 — Armature Bearing Cap Removal

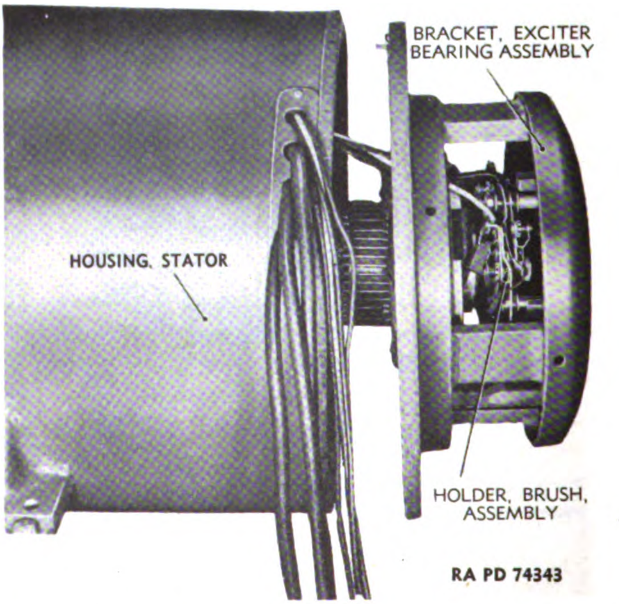


Figure 189 — Exciter Bearing Bracket Removal — H. B. Co. Unit

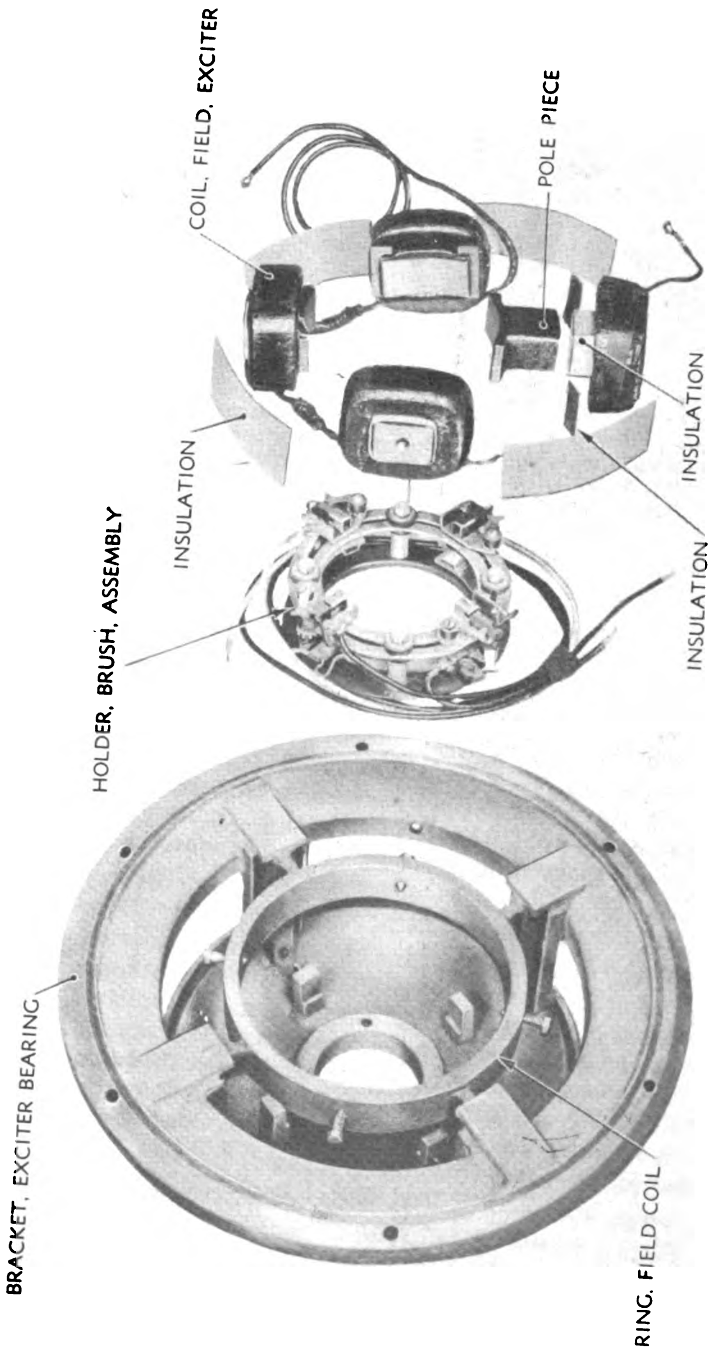


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Figure 190 — Exciter Bearing Bracket with Coils and Brush-holder Ring Assembly Removed

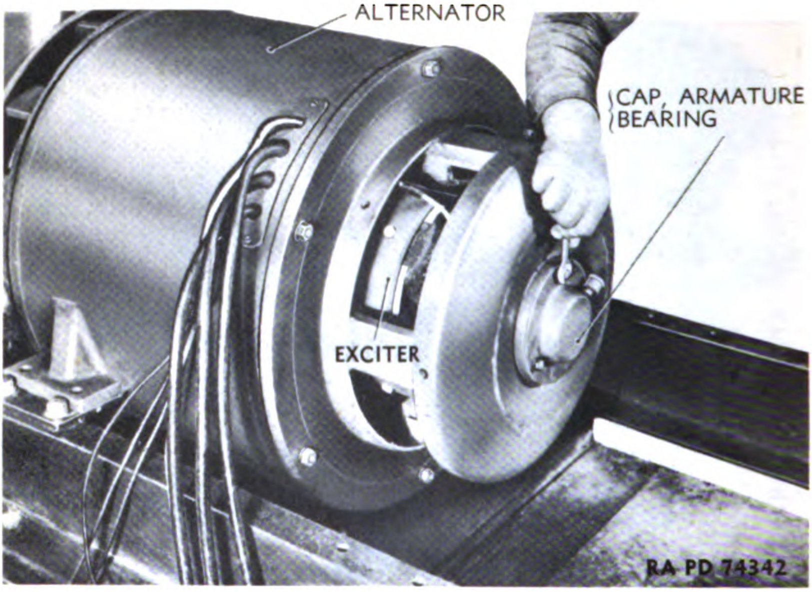

Figure 188 — Armature Bearing Cap Removal

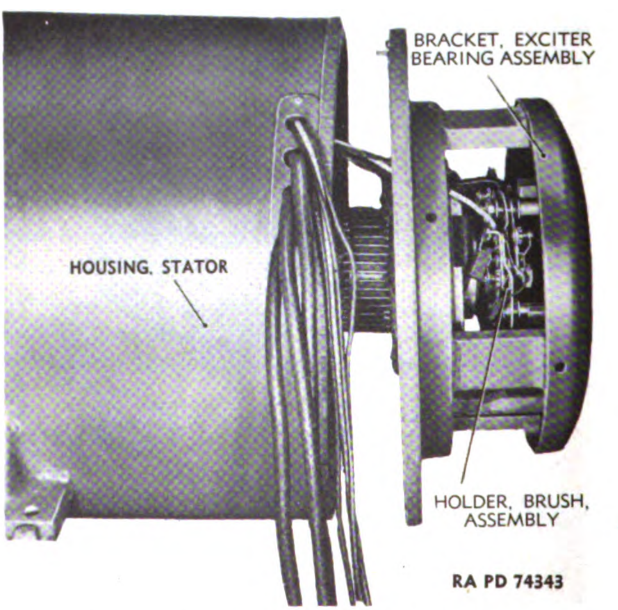

Figure 189 — Exciter Bearing Bracket Removal — H. B. Co. Unit

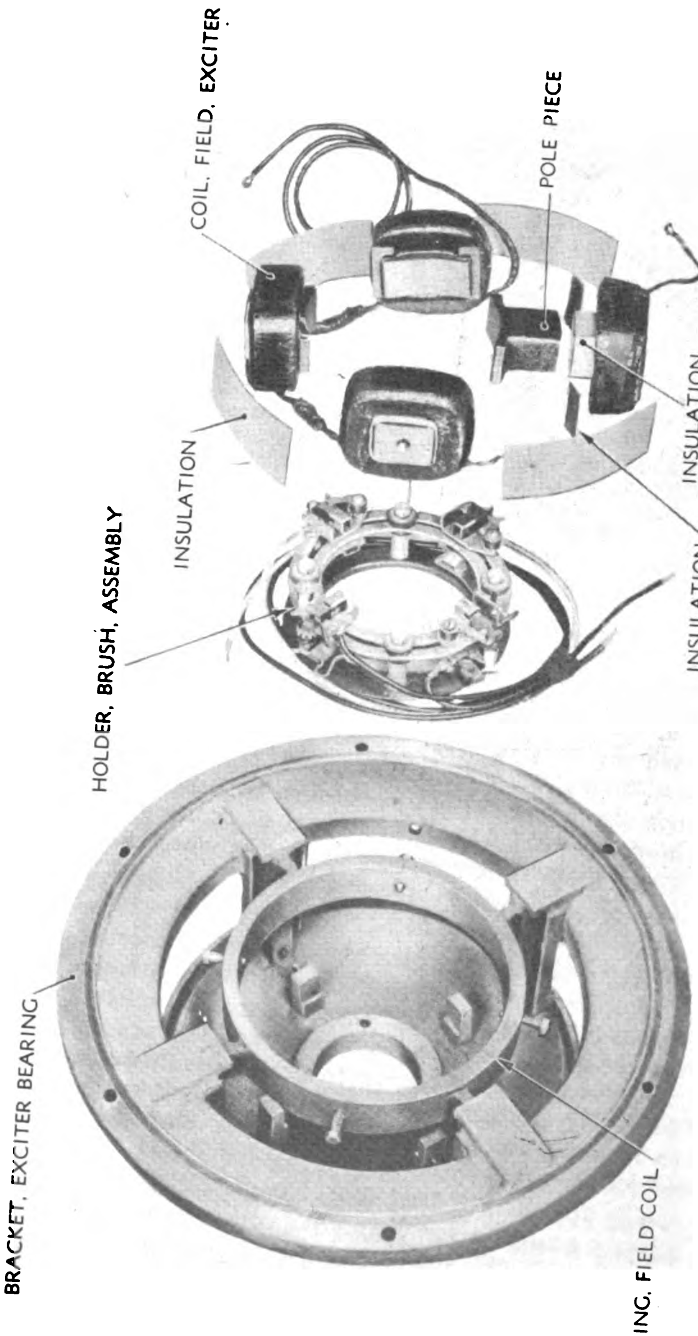

Figure 190 — Exciter Bearing Bracket with Coils and Brush-holder Ring Assembly Removed

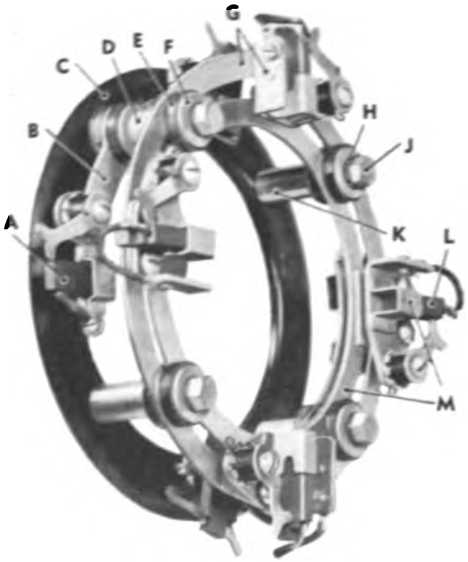

Figure 191 — Brush-holder Ring Assembly

circuit is present. If lamp fails to light, trace revolving field coil wires along armature shaft keyway under exciter armature. Remove tape from connections by which the two wires are joined to field coil leads. Repeat test lamp check with probes on the two exposed connections. If lamp now lights, but did not in the first test, open circuit is in the slip ring to revolving field coil wires or their connections. If the test lamp still fails to light, remove tape from the connections of field coil leads. Test each coil and each connection individually for an open circuit.

(2) Test revolving field coils for a ground by placing one probe of a test lamp on one slip ring. Place other probe on the armature shaft or paint-free portion of fan. If test lamp fails to light, no ground is present. If test lamp lights, disconnect both leads of each coil and repeat test on each. Place one probe on bare end of one of disconnected leads. Place other probe on armature shaft or fan. Similarly test each revolving field coil wire. Each time the test lamp lights, a grounded coil or wire is indicated.

(3) Test revolving field coils for a short circuit by connecting a 6-volt battery to the two slip rings. Using a 0- to 7½-volt voltmeter equipped with sharp probes, measure voltage drop across each coil. This is done by inserting one probe into one lead of a coil. Insert other probe into the other lead. Observe the reading of the voltmeter.

Repeat test on each of the coils, observing voltmeter each time. If any coil has a reading appreciably less than the others, a short circuit is indicated in that coil. NOTE: If the voltmeter hand moves in the wrong direction, reverse the probes.

(4) H. B. Co. UNIT ONLY. Test the exciter armature for a ground with test lamp. Place one probe on a commutator bar. Place the other probe on the armature shaft or paint-free portion of the fan. If lamp lights, a ground is indicated. Failure of the lamp to light shows no ground to be present.

(5) H. B. Co. UNIT ONLY. Test exciter armature for a short circuit by placing it in an armature growler. Turn on the growler. Move the steel strip slowly around the armature coils. Keep it parallel with the shaft. Turn off the growler and revolve the armature one-half turn in the growler. Turn on the growler, and test the other side of the armature. If the steel strip vibrates noticeably or is drawn to the laminations, a short circuit is indicated.

(6) H. B. Co. UNIT ONLY. Inspect the commutator bars. Look for burs which might short circuit two adjacent bars. Observe whether or not bars are scored.

(7) Inspect slip rings to see if they are scored. (This is a rare condition.) Examine slip ring separator to see if it has been broken due to improper disassembly.

(8) Examine alternator bearing to see if it is worn or broken. Examine balls and races to see if they are nicked or scored. Slide bearing on shaft. Grasp outer race and attempt to rock bearing on shaft. Presence of perceptible play indicates wear. If bearings are damaged, examine armature shaft to see if it is scored.

c. Inspect Body and Stator.

(1) Test stator windings for an open circuit with a test lamp. Place one probe on the tip of any one of the six main generator leads from stator. Touch each of the five remaining leads, one at a time, with the other probe. If lamp fails to light when any one of the leads is touched, an open circuit is indicated. If the lamp lights each time, no open circuit is indicated.

(2) Test the stator windings for a ground with a test lamp. Place one test lamp probe against an unpainted surface on the body. Place other probe against tip of any one of the six main generator leads. If lamp lights, a ground is indicated. If lamp fails to light no ground is present.

(3) Test stator windings for a short circuit with a stator growler. Place growler within body and stator so that steel strip is parallel and next to stator laminations. Turn on growler. Move growler slowly around entire inner circumference of stator. If stator windings have a short circuit, growler will "growl," due to vibration of the steel switch.

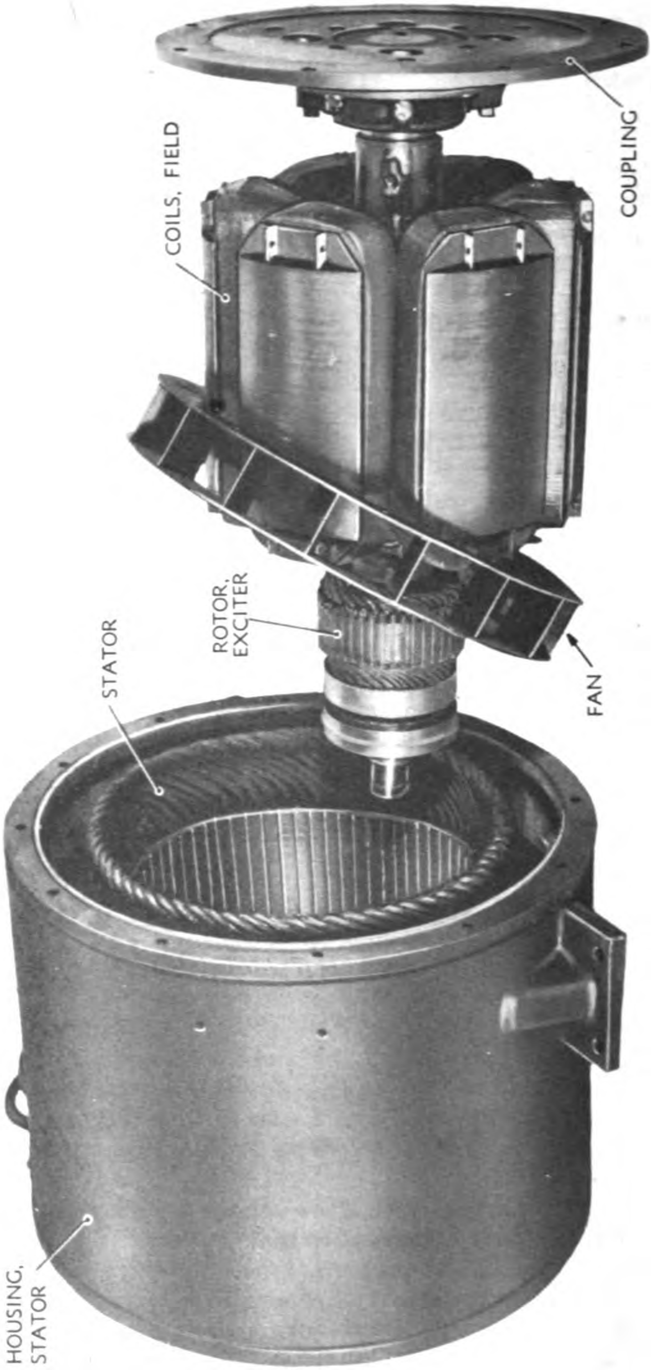

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Figure 192 — Stator Removed

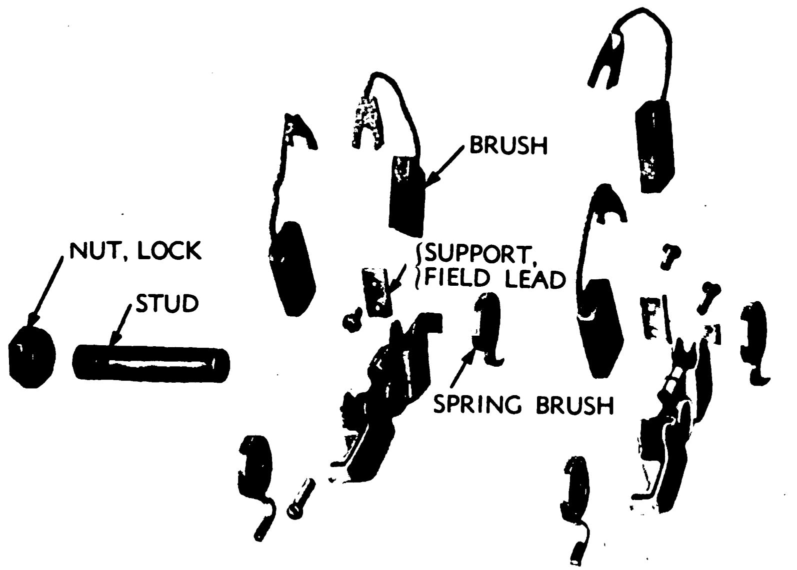


Figure 193 — Brush-holder Assembly — Exploded View

d. Inspect Exciter Bearing Bracket Assembly (H. B. Co. Unit only).

(1) Test exciter field coils for an open circuit with test lamp. Place one probe of test lamp on tip of exciter field coil to exciter brush wire. Touch other probe to the tip of main generator lead "1." If the lamp lights, no open circuit is present. If the lamp fails to light, an open circuit is indicated. In the presence of an open circuit, remove tape and cut connections of leads between coils. Test each coil individually. If the lamp fails to light, an open circuit is indicated.

(2) Test exciter field coils for ground with a test lamp. Hold one probe against a bare lead from the coil. Place other probe against the pole piece. If lamp lights, a ground is present. Failure of lamp to light indicates coil is free of grounds.

(3) Test exciter field coils for short circuits. This test is made with all coils connected in series. It can be made with coils installed in or removed from the exciter bearing bracket. Connect the six-volt battery to exciter field coil to commutator wire, and to main generator lead "1." Using a 0- to 7½-volt voltmeter equipped with sharp pointed probes, measure the voltage drop across each coil. Push one probe into one lead of a coil. Push other probe into other lead of same coil. Observe reading on the voltmeter. Repeat test on each of remaining three coils, observing reading on the voltmeter each time. If the reading on one coil is appreciably less than that of the other

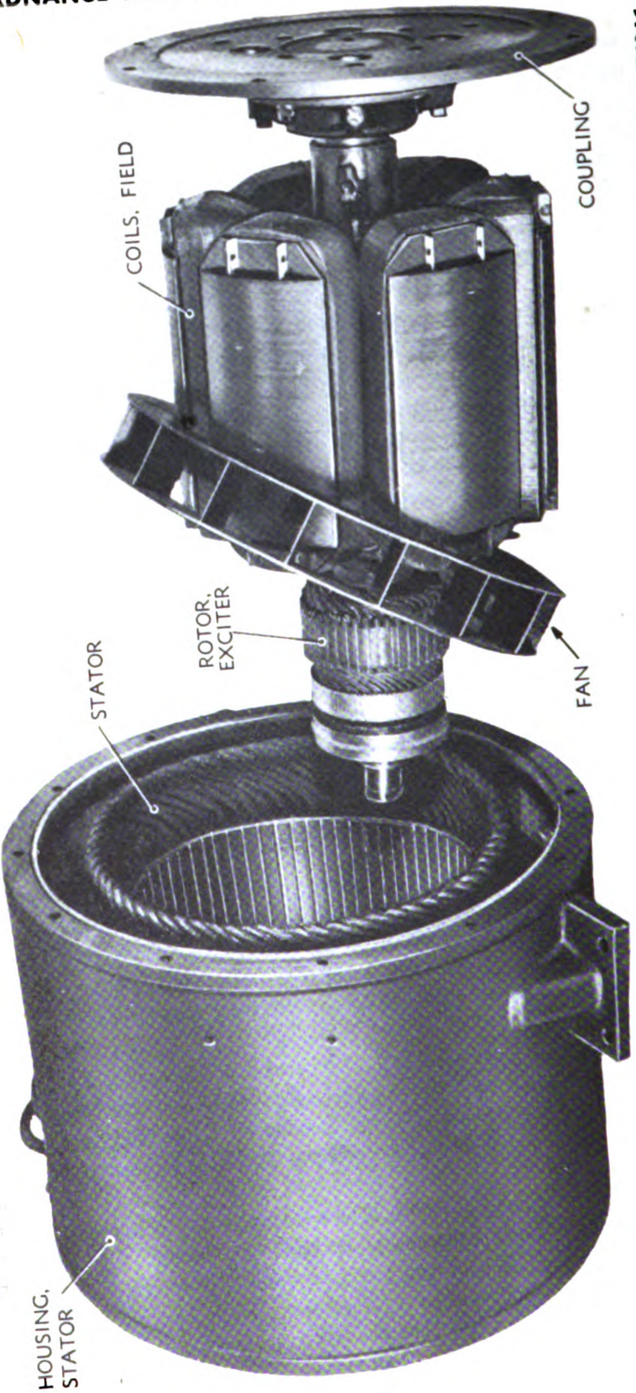


Figure 192 — Stator Removed

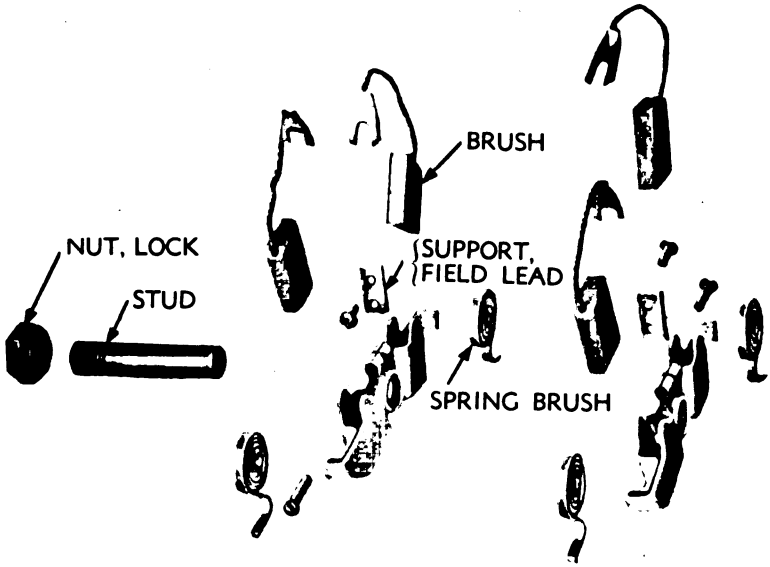


Figure 193 — Brush-holder Assembly — Exploded View

d. Inspect Exciter Bearing Bracket Assembly (H. B. Co. Unit only).

(1) Test exciter field coils for an open circuit with test lamp. Place one probe of test lamp on tip of exciter field coil to exciter brush wire. Touch other probe to the tip of main generator lead "1." If the lamp lights, no open circuit is present. If the lamp fails to light, an open circuit is indicated. In the presence of an open circuit, remove tape and cut connections of leads between coils. Test each coil individually. If the lamp fails to light, an open circuit is indicated.

(2) Test exciter field coils for ground with a test lamp. Hold one probe against a bare lead from the coil. Place other probe against the pole piece. If lamp lights, a ground is present. Failure of lamp to light indicates coil is free of grounds.

(3) Test exciter field coils for short circuits. This test is made with all coils connected in series. It can be made with coils installed in or removed from the exciter bearing bracket. Connect the six-volt battery to exciter field coil to commutator wire, and to main generator lead "1." Using a 0- to 7½-volt voltmeter equipped with sharp pointed probes, measure the voltage drop across each coil. Push one probe into one lead of a coil. Push other probe into other lead of same coil. Observe reading on the voltmeter. Repeat test on each of remaining three coils, observing reading on the voltmeter each time. If the reading on one coil is appreciably less than that of the other

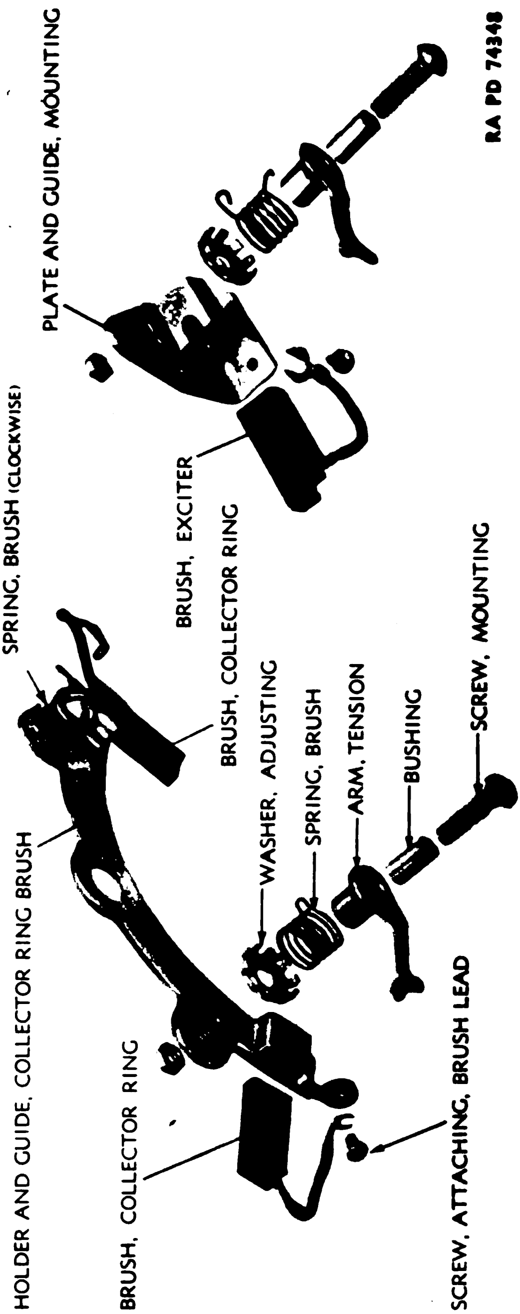


Figure 194 — Brush-holder Assembly (H. B. Co. Unit) — Exploded View

coils, a short circuit in that coil is indicated. If the reading is approximately equal on all coils, no short circuit is present. NOTE: If voltmeter hand moves in the wrong direction, reverse the probes.

(4) Inspect brushes to see if they are broken or worn. Measure length of each brush. Any brush that is ¾ inch or less in length must be replaced.

(5) Examine threads of all screws and tapped threads in screw holes to see if they are burred or stripped.

(6) Inspect brush tension arm springs to see if they are broken or weak.

(7) Examine all insulator spacers and bushings to see if they are broken.

(8) Inspect all metal parts to see if they are bent, worn, or broken.

e. Inspect Coupling End Generator Parts.

(1) Inspect driving flange to see if it is bent or broken. Observe keyway to see if it is square and free of burs. Examine threads of the Allen set screws and threads tapped in screw holes to see if they are burred or stripped. Examine welds to see if any have broken loose.

(2) Inspect armature shaft bearing bracket to see if it is broken. Examine threads in tapped screw holes and lubrication pipe nipple hole to see if they are burred or stripped. Inspect lubrication pipe nipple, elbow, and grease cup to see if they are broken, bent, plugged, or have damaged threads.

(3) Inspect grease retainer to see if it is bent or if welds have broken loose. Examine felt washer to see if it is torn, worn, or grease-soaked. Inspect the gasket to see if it is torn.

(4) Examine fan cover to see if it is bent or broken.

(5) Examine all screws and lock washers to see if they are broken. Note whether or not screw threads are burred or stripped.

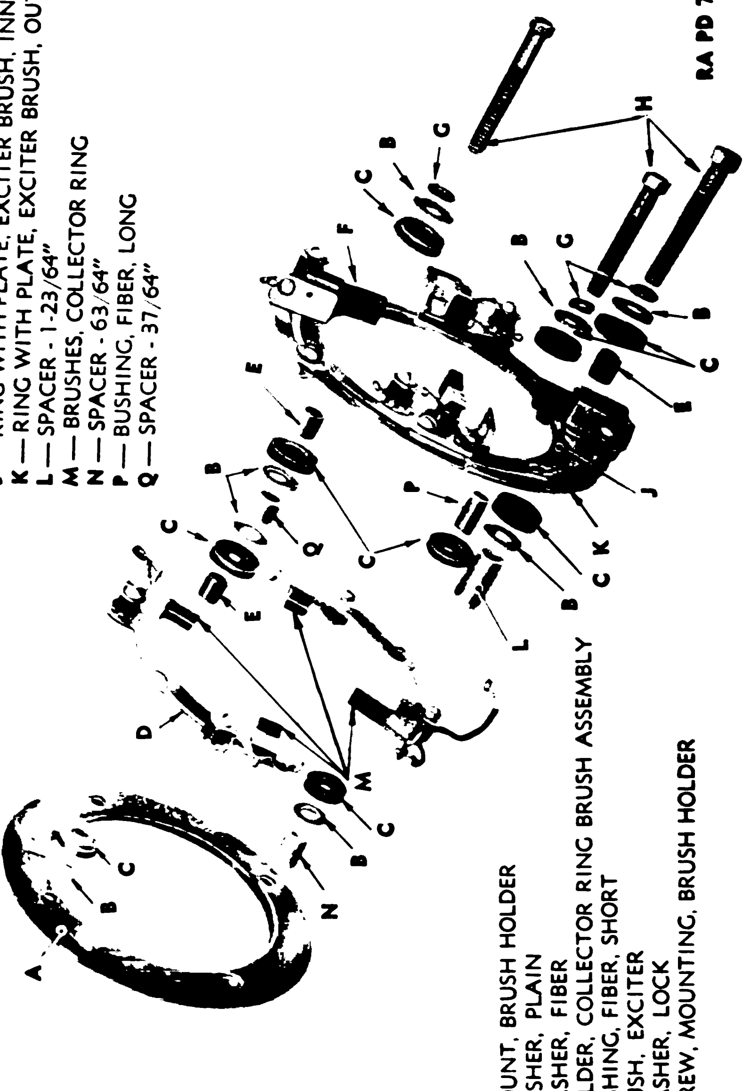
94. MAINTENANCE AND REPAIRS.

a. Revolving Field Coils.

(1) In case of an open circuit in a revolving field coil, replace coil. Weigh coil to be discarded, and weigh the new coil. Use a new coil having the same weight as the one removed to preserve rotor assembly balance. In case the open circuit is in a connection, peel back insulation on the wire. Twist wires together and weld. Push boom over connection and wrap with black insulating tape. Paint tape with GLYPTAL, black.

(2) In case a revolving field coil is grounded, replace coil and all insulators. If a connection is grounded, replace old tape with new black insulating tape, and paint tape with GLYPTAL, black.

J — RING WITH PLATE, EXCITER BRUSH, INNER, ASSEMBLY
K — RING WITH PLATE, EXCITER BRUSH, OUTER, ASSEMBLY
L — SPACER - 1-23/64"
M — BRUSHES, COLLECTOR RING
N — SPACER - 63/64"
P — BUSHING, FIBER, LONG
Q — SPACER - 37/64"



A — MOUNT, BRUSH HOLDER
B — WASHER, PLAIN
C — WASHER, FIBER
D — HOLDER, COLLECTOR RING BRUSH ASSEMBLY
E — BUSHING, FIBER, SHORT
F — BRUSH, EXCITER
G — WASHER, LOCK
H — SCREW, MOUNTING, BRUSH HOLDER

Figure 195 — Brush-holder Ring Assembly (H. B. Co. Unit) — Exploded View

(3) Replace short-circuited revolving field coils.

b. Exciter Armature (H. B. Co. Unit Only).

(1) Examine exciter armature if it has an open circuit. If the cause is a wire pulled loose from a commutator bar, solder wire into slot in bar. Turn commutator bars down on a lathe and undercut the mica as described below. If break cannot be located, replace armature.

(2) If exciter armature is grounded or short-circuited, replace.

c. Commutator Bars (H. B. Co. Unit Only). If commutator bars are scored, place armature assembly in a lathe. Take a cut from commutator bars. Make the cut as light as possible, but deep enough to remove all score marks. Hold a piece of PAPER, flint, Class B, No. 2/0 against the revolving commutator bars to remove cutting tool marks. Remove armature from lathe and undercut mica to a depth of 0.025 inch between commutator bars.

d. Slip Rings.

(1) If the slip rings are scored, place armature in lathe. Take a cut off each slip ring. Remove only enough metal to eliminate the score marks. Hold a piece of PAPER, flint, Class B, No. 2/0 against the revolving slip rings to remove cutting tool marks.

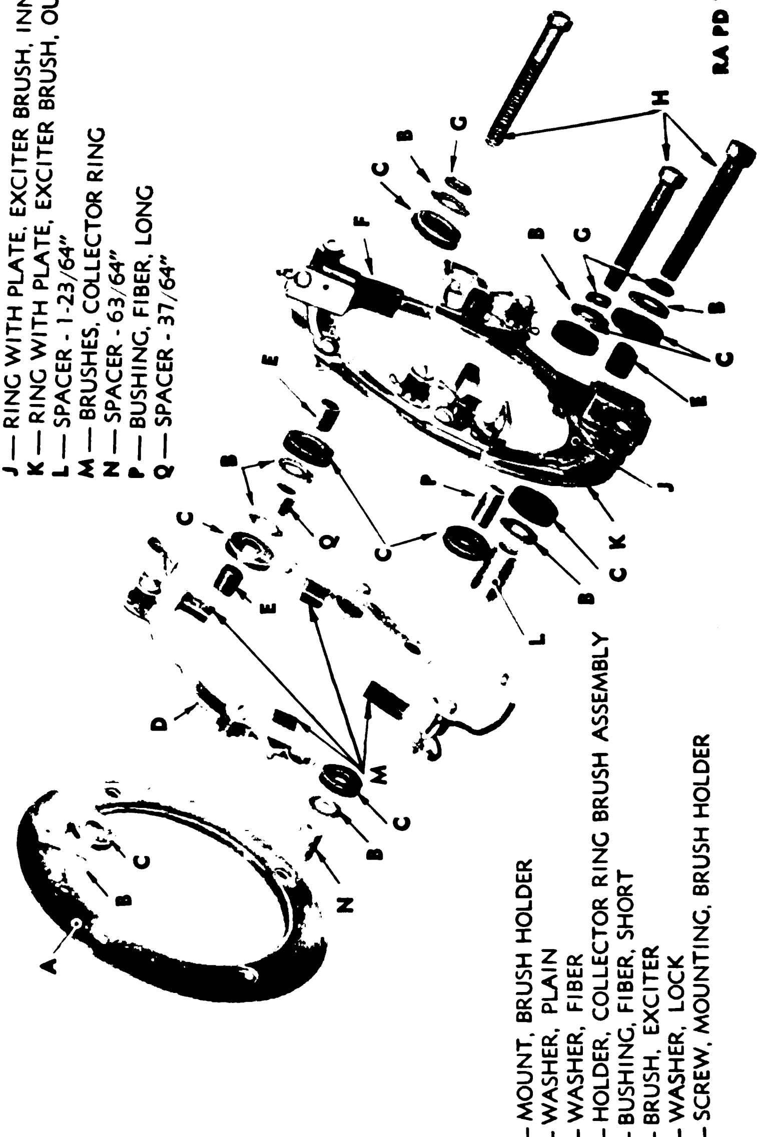
(2) If the slip ring separator is broken, melt the solder which secures the revolving field wire to outer slip ring, and pry wire from slip ring. Remove the six commutator ring screws. Tap threads in two screw holes in the commutator ring on opposite sides of shaft with $\frac{5}{16}$-18 thread tap. Using a gear puller, pull the commutator ring from shaft. Lift slip ring and mica ring from shaft. Lift slip ring separator from shaft. Place a new slip ring separator in position on shaft. Place slip ring in position on the commutator ring with the mica in position between the two parts. Start assembly on shaft. Be sure screw holes line up. Tap commutator ring carefully on shaft. Install six commutator ring screws. Solder revolving field wire to outer slip ring.

e. Shaft. Replace armature shaft bearing if worn or broken. If shaft is scored due to bearing failure, smooth off ridges with a fine mill file. Do not attempt to eliminate score marks. Smooth it just enough so bearing can be pressed on. In case shaft is damaged enough to be undersize, replace armature assembly.

f. Fan. Straighten fan if bent. If welds have broken loose, re-weld. Be careful to preserve balance by using a very small amount of welding metal. Spot welds evenly.

g. Stator Windings.

(1) If stator windings have an open circuit, it may be due to a loose conection. If an open circuit is indicated in the stator, remove



A — MOUNT, BRUSH HOLDER
B — WASHER, PLAIN
C — WASHER, FIBER
D — HOLDER, COLLECTOR RING BRUSH ASSEMBLY
E — BUSHING, FIBER, SHORT
F — BRUSH, EXCITER
G — WASHER, LOCK
H — SCREW, MOUNTING, BRUSH HOLDER

J — RING WITH PLATE, EXCITER BRUSH, INNER, ASSEMBLY
K — RING WITH PLATE, EXCITER BRUSH, OUTER, ASSEMBLY
L — SPACER - 1-23/64"
M — BRUSHES, COLLECTOR RING
N — SPACER - 63/64"
P — BUSHING, FIBER, LONG
Q — SPACER - 37/64"

RA PD 74349

Figure 195 — Brush-holder Ring Assembly (H. B. Co. Unit) — Exploded View

(3) Replace short-circuited revolving field coils.

b. Exciter Armature (H. B. Co. Unit Only).

(1) Examine exciter armature if it has an open circuit. If the cause is a wire pulled loose from a commutator bar, solder wire into slot in bar. Turn commutator bars down on a lathe and undercut the mica as described below. If break cannot be located, replace armature.

(2) If exciter armature is grounded or short-circuited, replace.

c. Commutator Bars (H. B. Co. Unit Only). If commutator bars are scored, place armature assembly in a lathe. Take a cut from commutator bars. Make the cut as light as possible, but deep enough to remove all score marks. Hold a piece of PAPER, flint, Class B, No. 2/0 against the revolving commutator bars to remove cutting tool marks. Remove armature from lathe and undercut mica to a depth of 0.025 inch between commutator bars.

d. Slip Rings.

(1) If the slip rings are scored, place armature in lathe. Take a cut off each slip ring. Remove only enough metal to eliminate the score marks. Hold a piece of PAPER, flint, Class B, No. 2/0 against the revolving slip rings to remove cutting tool marks.

(2) If the slip ring separator is broken, melt the solder which secures the revolving field wire to outer slip ring, and pry wire from slip ring. Remove the six commutator ring screws. Tap threads in two screw holes in the commutator ring on opposite sides of shaft with $^5\!/_{16}$-18 thread tap. Using a gear puller, pull the commutator ring from shaft. Lift slip ring and mica ring from shaft. Lift slip ring separator from shaft. Place a new slip ring separator in position on shaft. Place slip ring in position on the commutator ring with the mica in position between the two parts. Start assembly on shaft. Be sure screw holes line up. Tap commutator ring carefully on shaft. Install six commutator ring screws. Solder revolving field wire to outer slip ring.

e. Shaft. Replace armature shaft bearing if worn or broken. If shaft is scored due to bearing failure, smooth off ridges with a fine mill file. Do not attempt to eliminate score marks. Smooth it just enough so bearing can be pressed on. In case shaft is damaged enough to be undersize, replace armature assembly.

f. Fan. Straighten fan if bent. If welds have broken loose, re-weld. Be careful to preserve balance by using a very small amount of welding metal. Spot welds evenly.

g. Stator Windings.

(1) If stator windings have an open circuit, it may be due to a loose conection. If an open circuit is indicated in the stator, remove

(3) Replace short-circuited revolving field coils.

b. Exciter Armature (H. B. Co. Unit Only).

(1) Examine exciter armature if it has an open circuit. If the cause is a wire pulled loose from a commutator bar, solder wire into slot in bar. Turn commutator bars down on a lathe and undercut the mica as described below. If break cannot be located, replace armature.

(2) If exciter armature is grounded or short-circuited, replace.

c. Commutator Bars (H. B. Co. Unit Only). If commutator bars are scored, place armature assembly in a lathe. Take a cut from commutator bars. Make the cut as light as possible, but deep enough to remove all score marks. Hold a piece of PAPER, flint, Class B, No. 2/0 against the revolving commutator bars to remove cutting tool marks. Remove armature from lathe and undercut mica to a depth of 0.025 inch between commutator bars.

d. Slip Rings.

(1) If the slip rings are scored, place armature in lathe. Take a cut off each slip ring. Remove only enough metal to eliminate the score marks. Hold a piece of PAPER, flint, Class B, No. 2/0 against the revolving slip rings to remove cutting tool marks.

(2) If the slip ring separator is broken, melt the solder which secures the revolving field wire to outer slip ring, and pry wire from slip ring. Remove the six commutator ring screws. Tap threads in two screw holes in the commutator ring on opposite sides of shaft with $\frac{5}{16}$-18 thread tap. Using a gear puller, pull the commutator ring from shaft. Lift slip ring and mica ring from shaft. Lift slip ring separator from shaft. Place a new slip ring separator in position on shaft. Place slip ring in position on the commutator ring with the mica in position between the two parts. Start assembly on shaft. Be sure screw holes line up. Tap commutator ring carefully on shaft. Install six commutator ring screws. Solder revolving field wire to outer slip ring.

***e.* Shaft.** Replace armature shaft bearing if worn or broken. If shaft is scored due to bearing failure, smooth off ridges with a fine mill file. Do not attempt to eliminate score marks. Smooth it just enough so bearing can be pressed on. In case shaft is damaged enough to be undersize, replace armature assembly.

***f.* Fan.** Straighten fan if bent. If welds have broken loose, re-weld. Be careful to preserve balance by using a very small amount of welding metal. Spot welds evenly.

g. Stator Windings.

(1) If stator windings have an open circuit, it may be due to a loose conection. If an open circuit is indicated in the stator, remove

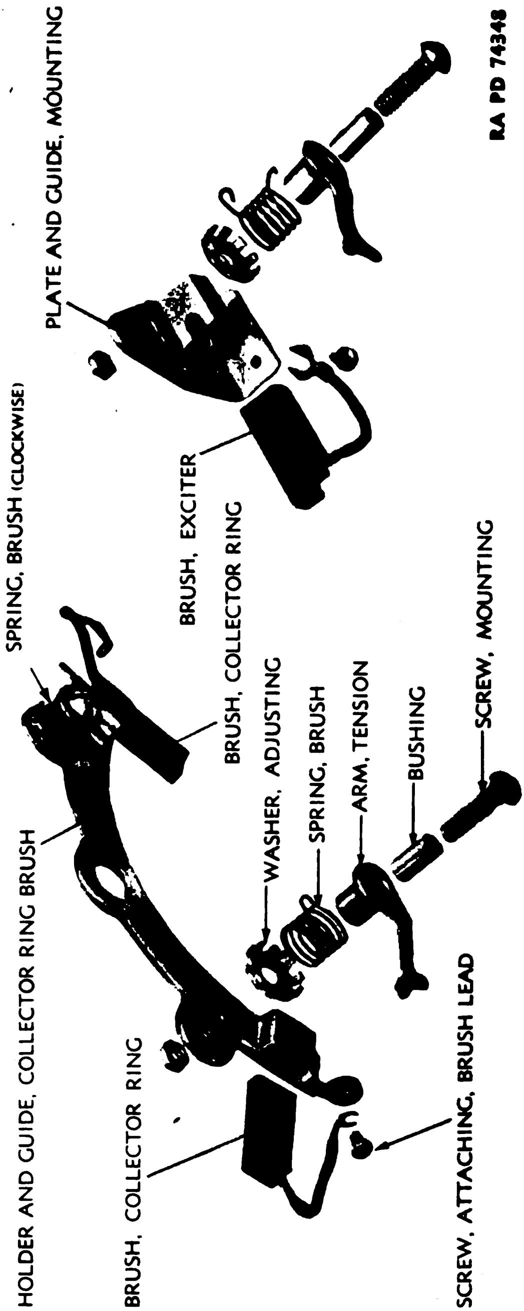


Figure 194 — Brush-holder Assembly (H. B. Co. Unit) — Exploded View

coils, a short circuit in that coil is indicated. If the reading is approximately equal on all coils, no short circuit is present. NOTE: If voltmeter hand moves in the wrong direction, reverse the probes.

(4) Inspect brushes to see if they are broken or worn. Measure length of each brush. Any brush that is ¾ inch or less in length must be replaced.

(5) Examine threads of all screws and tapped threads in screw holes to see if they are burred or stripped.

(6) Inspect brush tension arm springs to see if they are broken or weak.

(7) Examine all insulator spacers and bushings to see if they are broken.

(8) Inspect all metal parts to see if they are bent, worn, or broken.

e. Inspect Coupling End Generator Parts.

(1) Inspect driving flange to see if it is bent or broken. Observe keyway to see if it is square and free of burs. Examine threads of the Allen set screws and threads tapped in screw holes to see if they are burred or stripped. Examine welds to see if any have broken loose.

(2) Inspect armature shaft bearing bracket to see if it is broken. Examine threads in tapped screw holes and lubrication pipe nipple hole to see if they are burred or stripped. Inspect lubrication pipe nipple, elbow, and grease cup to see if they are broken, bent, plugged, or have damaged threads.

(3) Inspect grease retainer to see if it is bent or if welds have broken loose. Examine felt washer to see if it is torn, worn, or grease-soaked. Inspect the gasket to see if it is torn.

(4) Examine fan cover to see if it is bent or broken.

(5) Examine all screws and lock washers to see if they are broken. Note whether or not screw threads are burred or stripped.

94. MAINTENANCE AND REPAIRS.

a. Revolving Field Coils.

(1) In case of an open circuit in a revolving field coil, replace coil. Weigh coil to be discarded, and weigh the new coil. Use a new coil having the same weight as the one removed to preserve rotor assembly balance. In case the open circuit is in a connection, peel back insulation on the wire. Twist wires together and weld. Push boom over connection and wrap with black insulating tape. Paint tape with GLYPTAL, black.

(2) In case a revolving field coil is grounded, replace coil and all insulators. If a connection is grounded, replace old tape with new black insulating tape, and paint tape with GLYPTAL, black.

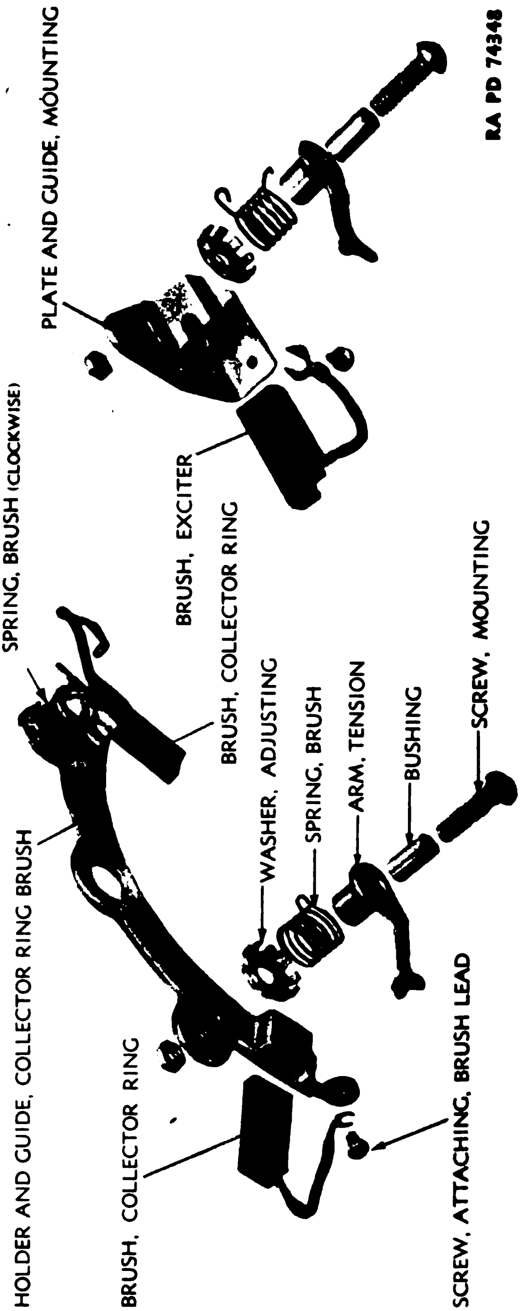


Figure 194 — Brush-holder Assembly (H. B. Co. Unit) — Exploded View

coils, a short circuit in that coil is indicated. If the reading is approximately equal on all coils, no short circuit is present. NOTE: If voltmeter hand moves in the wrong direction, reverse the probes.

(4) Inspect brushes to see if they are broken or worn. Measure length of each brush. Any brush that is ¾ inch or less in length must be replaced.

(5) Examine threads of all screws and tapped threads in screw holes to see if they are burred or stripped.

(6) Inspect brush tension arm springs to see if they are broken or weak.

(7) Examine all insulator spacers and bushings to see if they are broken.

(8) Inspect all metal parts to see if they are bent, worn, or broken.

e. Inspect Coupling End Generator Parts.

(1) Inspect driving flange to see if it is bent or broken. Observe keyway to see if it is square and free of burs. Examine threads of the Allen set screws and threads tapped in screw holes to see if they are burred or stripped. Examine welds to see if any have broken loose.

(2) Inspect armature shaft bearing bracket to see if it is broken. Examine threads in tapped screw holes and lubrication pipe nipple hole to see if they are burred or stripped. Inspect lubrication pipe nipple, elbow, and grease cup to see if they are broken, bent, plugged, or have damaged threads.

(3) Inspect grease retainer to see if it is bent or if welds have broken loose. Examine felt washer to see if it is torn, worn, or grease-soaked. Inspect the gasket to see if it is torn.

(4) Examine fan cover to see if it is bent or broken.

(5) Examine all screws and lock washers to see if they are broken. Note whether or not screw threads are burred or stripped.

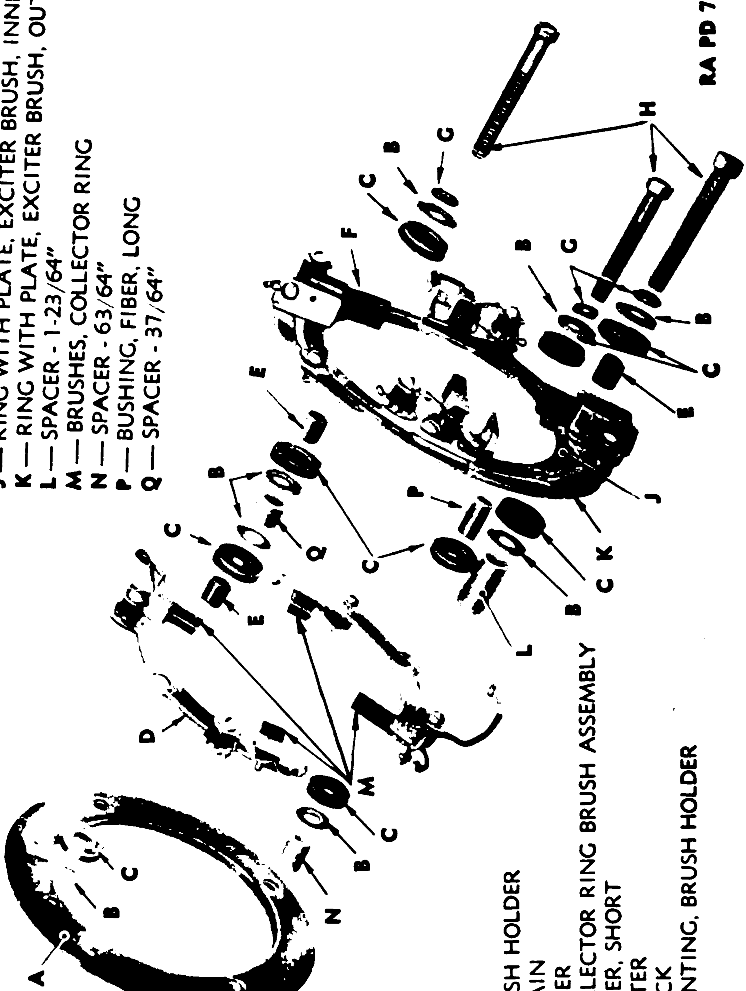
94. MAINTENANCE AND REPAIRS.

a. Revolving Field Coils.

(1) In case of an open circuit in a revolving field coil, replace coil. Weigh coil to be discarded, and weigh the new coil. Use a new coil having the same weight as the one removed to preserve rotor assembly balance. In case the open circuit is in a connection, peel back insulation on the wire. Twist wires together and weld. Push boom over connection and wrap with black insulating tape. Paint tape with GLYPTAL, black.

(2) In case a revolving field coil is grounded, replace coil and all insulators. If a connection is grounded, replace old tape with new black insulating tape, and paint tape with GLYPTAL, black.

J — RING WITH PLATE, EXCITER BRUSH, INNER, ASSEMBLY
K — RING WITH PLATE, EXCITER BRUSH, OUTER, ASSEMBLY
L — SPACER - 1-23/64"
M — BRUSHES, COLLECTOR RING
N — SPACER - 63/64"
P — BUSHING, FIBER, LONG
Q — SPACER - 37/64"



A — MOUNT, BRUSH HOLDER
B — WASHER, PLAIN
C — WASHER, FIBER
D — HOLDER, COLLECTOR RING BRUSH ASSEMBLY
E — BUSHING, FIBER, SHORT
F — BRUSH, EXCITER
G — WASHER, LOCK
H — SCREW, MOUNTING, BRUSH HOLDER

Figure 195 — Brush-holder Ring Assembly (H. B. Co. Unit) — Exploded View

(3) Replace short-circuited revolving field coils.

b. Exciter Armature (H. B. Co. Unit Only).

(1) Examine exciter armature if it has an open circuit. If the cause is a wire pulled loose from a commutator bar, solder wire into slot in bar. Turn commutator bars down on a lathe and undercut the mica as described below. If break cannot be located, replace armature.

(2) If exciter armature is grounded or short-circuited, replace.

c. Commutator Bars (H. B. Co. Unit Only). If commutator bars are scored, place armature assembly in a lathe. Take a cut from commutator bars. Make the cut as light as possible, but deep enough to remove all score marks. Hold a piece of PAPER, flint, Class B, No. 2/0 against the revolving commutator bars to remove cutting tool marks. Remove armature from lathe and undercut mica to a depth of 0.025 inch between commutator bars.

d. Slip Rings.

(1) If the slip rings are scored, place armature in lathe. Take a cut off each slip ring. Remove only enough metal to eliminate the score marks. Hold a piece of PAPER, flint, Class B, No. 2/0 against the revolving slip rings to remove cutting tool marks.

(2) If the slip ring separator is broken, melt the solder which secures the revolving field wire to outer slip ring, and pry wire from slip ring. Remove the six commutator ring screws. Tap threads in two screw holes in the commutator ring on opposite sides of shaft with $\frac{5}{16}$-18 thread tap. Using a gear puller, pull the commutator ring from shaft. Lift slip ring and mica ring from shaft. Lift slip ring separator from shaft. Place a new slip ring separator in position on shaft. Place slip ring in position on the commutator ring with the mica in position between the two parts. Start assembly on shaft. Be sure screw holes line up. Tap commutator ring carefully on shaft. Install six commutator ring screws. Solder revolving field wire to outer slip ring.

e. Shaft. Replace armature shaft bearing if worn or broken. If shaft is scored due to bearing failure, smooth off ridges with a fine mill file. Do not attempt to eliminate score marks. Smooth it just enough so bearing can be pressed on. In case shaft is damaged enough to be undersize, replace armature assembly.

f. Fan. Straighten fan if bent. If welds have broken loose, re-weld. Be careful to preserve balance by using a very small amount of welding metal. Spot welds evenly.

g. Stator Windings.

(1) If stator windings have an open circuit, it may be due to a loose conection. If an open circuit is indicated in the stator, remove

old tape and loom from the connection which appears at fault. Examine welds. When the faulty connection is found, weld wires together. Cover all exposed connections with loom and tape with black insulating tape. Paint tape with GLYPTAL, black. If the open circuit is within a coil, replace stator.

(2) If stator windings are grounded, inspect all connections and lead wires for faulty insulation. Remove faulty insulation, replace loom and wrap the bared wire with black insulating tape. Paint tape with GLYPTAL, black. If ground cannot be located, it is probably in a coil and it will be necessary to replace stator.

(3) If stator windings are short-circuited, replace stator.

h. **Exciter Field Coils (H. B. Co. Unit Only).** Replace any exciter field coil having an open circuit, ground, or short circuit.

i. **Brushes.** Replace brushes if broken or worn to less than ¾ inch in length.

j. **Brush Tension Arm Springs.** Replace brush tension arm springs if they are broken or weak.

k. **Metal Parts.** Repair burred screw holes by running a thread tap through them. Straighten bent metal parts. Replace broken metal parts.

l. **Insulator Spacers and Bushing.** Replace all broken or doubtful insulator spacers and bushings.

m. **Driving Flange.** Replace pilot flange if it is bent, broken, or if the keyway is worn on edges. Remove burs from keyway with a fine mill file.

n. **Bearing Bracket.** Replace armature shaft bearing bracket if broken. Repair damaged threads by running a thread tap through them. Replace damaged grease cup.

95. ASSEMBLY.

a. **All Units Except H. B. Co.**

(1) Press pilot flange on shaft, first inserting key in shaft.

(2) Attach set of flexible disks to pilot flange with cap screws and nuts.

(3) Attach flywheel adapter to flexible disk set with nuts over the adapter studs.

(4) Connect the collector rings with screws through rings and center flange. Attach ring assembly to shaft with socket-head screws through flange. Carry long lead from field coil through spaces between rings and shaft to tapped holes in outer edge of outside collector ring. Attach with round-head screws. Connect short lead to inner edge of inside collector ring with screw to tapped hole.

(5) Press bearing on shaft.

(6) Install complete brush holder assembly on bearing bracket by screwing stud into tapped hole in bearing bracket. Secure in place with lock nut (fig. 193).

(7) Place bearing bracket in position, and secure to housing with cap screws.

(8) Insert rotor assembly into housing with the bearing in position in the bearing bracket.

(9) Install key in shaft slot. Force pulley into position on shaft. Place square washer in position at end of shaft at pulley. Secure with flat-head screw. Lock screw into place by punching hole in washer at each end of screw slot so that punched out metal will hold screw firmly.

b. H. B. Co. Unit (Alternator and Exciter).

(1) Install coupling. Follow procedure given in subparagraph a (1), (2), and (3), above.

(2) Assemble mounting screw and bushing through tension arm sleeve. Place spring on sleeve, and set spring adjusting washer over spring. Carry screw through brush holder and guide, or mounting plate and guide, and attach nut. Repeat this procedure for each brush holder (fig. 194).

(3) Assemble brush-holder rings (fig. 195) by installing on each of the four mounting screws a plain washer and a fiber washer, then carry the cap screws through the exciter brush rings. On each of one pair of opposite screws install, below the exciter rings, a fiber washer, a plain washer, and a large size spacer ($1\frac{23}{64}$ inch). On one of the other two screws, install below the exciter rings a short fiber bushing, a fiber washer, a plain washer, a short spacer ($\frac{37}{64}$ inch), a metal washer, a fiber washer, a short fiber bushing, and a collector ring holder, spring side up, then a fiber washer and a metal washer. On the fourth cap screw, install below the exciter rings, a long fiber bushing, a fiber washer, a collector ring holder, spring side down, a fiber washer, a plain washer, and a medium spacer ($\frac{63}{64}$ inch). This complete assembly is now screwed through to the brush-holder mount with the mounting screws.

(4) Place brush-holder ring assembly in position in exciter bearing bracket, and secure with set screws to groove in brush-holder mount.

(5) Place exciter field coils in position in field coil ring with connecting wires toward the small end of the bracket. Arrange insulation sheets behind wires. Insert pole pieces through coils with insulation rings in position. Secure coils with cap screws through field coil ring to pole pieces.

(6) Press grease retainer on shaft. Press roller bearing on shaft into position in exciter bearing bracket.

(7) Insert rotor into position in housing with fan assembly in place but not secured.

(8) Bring exciter bearing bracket into position at housing, and make the following wiring connections. Carry a lead from one exciter brush terminal to connection post "A1" on the terminal block. Carry a lead from the adjacent brush connection to post "A2" on the terminal block. Bring a lead from one collector ring brush holder terminal to post "A1" on the terminal block. Take a lead from the opposite collector ring brush terminal to exciter brush connected to "A2" on the terminal block. Take the short lead from the exciter field coil assembly and attach it to the exciter brush connection opposite the one to which the "A2" exciter lead is connected. Connect long lead from exciter field coil to terminal block post "F."

(9) Attach exciter bearing bracket to housing with cap screws.

(10) Screw nut on shaft end.

(11) Place cover and gasket in position, and attach exciter bearing bracket cover to bracket with screws.

96. INSTALLATION.

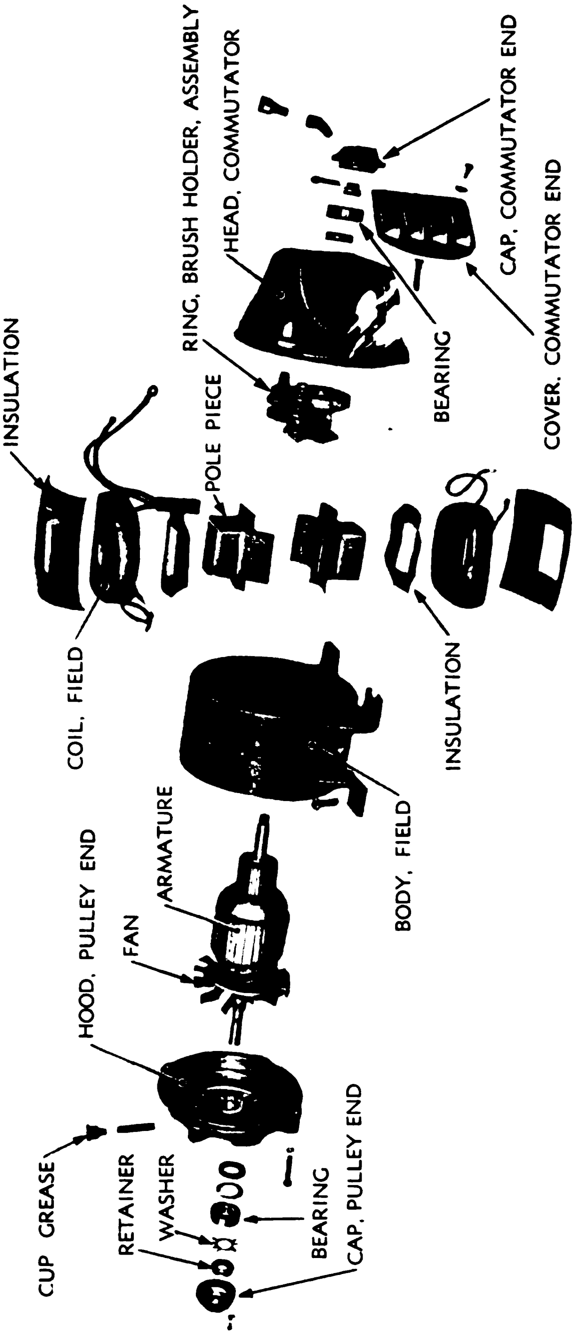
a. **All Units Except H. B. Co.** Install alternator. Reverse procedure specified in paragraph 91. (See paragraph 15 for housing installation.)

Section III

EXCITER

97. DESCRIPTION.

a. The exciter is a d-c generator connected to the alternator shaft by V-belts (except on H. B. Co. units). The exciter supplies direct, or excitation, current to the field coils of the alternator. The exciter weighs 160 lb and at 1,800 rpm the rated output is 1-kw, 6.25-v, 16-amp with 40 C temperature rise.



RA PD 74352

Figure 196 — Exciter Assembly — Exploded View

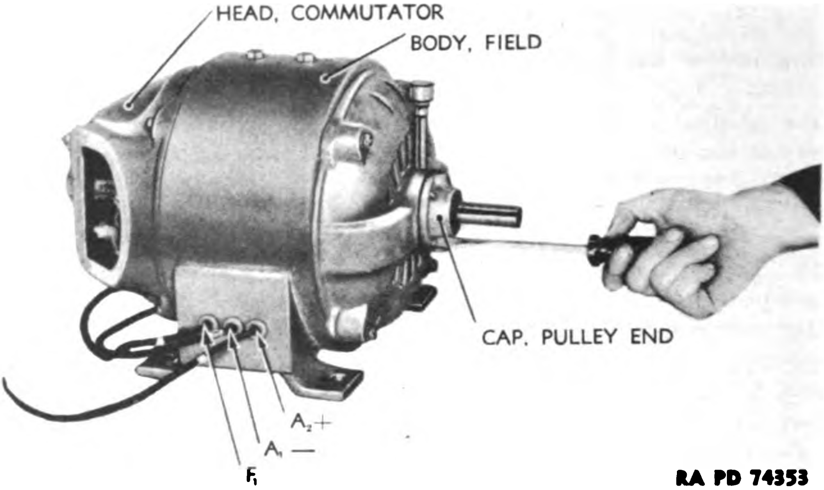


Figure 197 – Exciter Pulley End Cap Removal

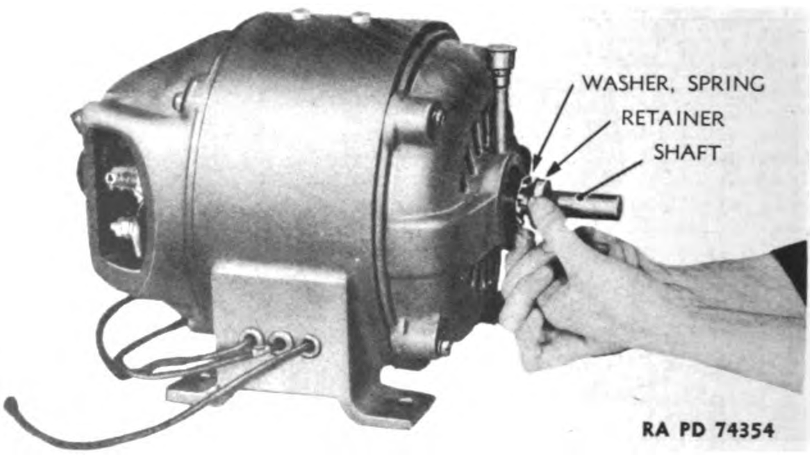


Figure 198 – Exciter Retainer Ring Removal

98. REMOVAL (Units Other Than H. B. Co.).

a. Procedure.

(1) Loosen hold-down clamp nuts and remove clamps. Loosen battery leads, and remove leads from battery posts. Remove battery and inside tray. Remove nuts from cap screws through battery tray flange, and lift tray off. Remove nuts from bolts through bottom of tool box, and remove box.

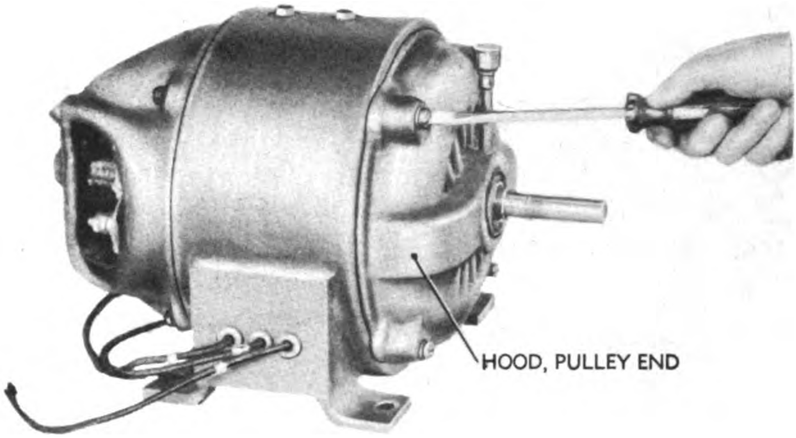


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Figure 199 — Exciter Pulley End Hood Removal

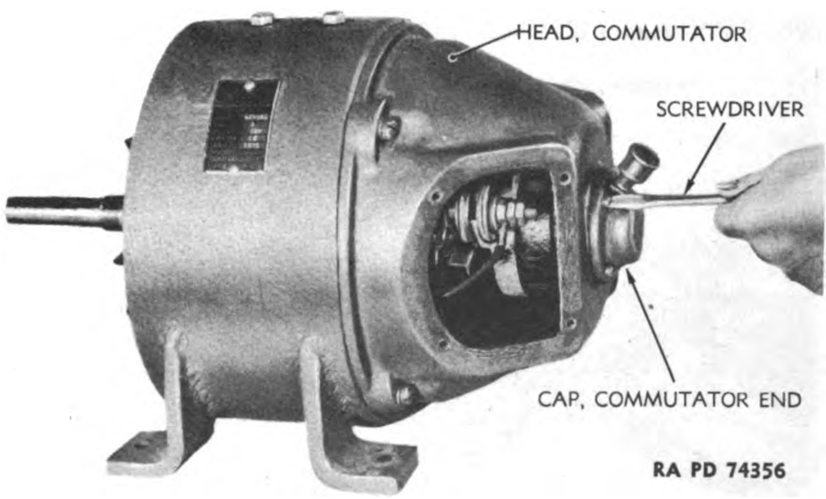

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Figure 200 — Exciter Commutator End Cap Removal

(2) Take off wing nuts and lock washers holding guard panel to uprights, and remove panel.

(3) Trace exciter leads from exciter to terminal block, take out connecting screws, and remove leads.

(4) Remove belts connecting exciter and alternator. Take out cap screws holding exciter to adjustable plate on top of alternator, and remove exciter.

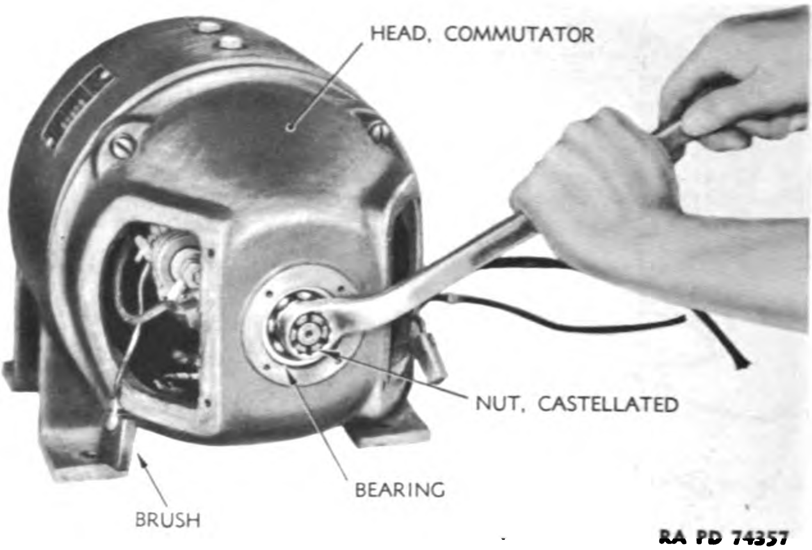

Figure 201 — Exciter Shaft End Nut Removal

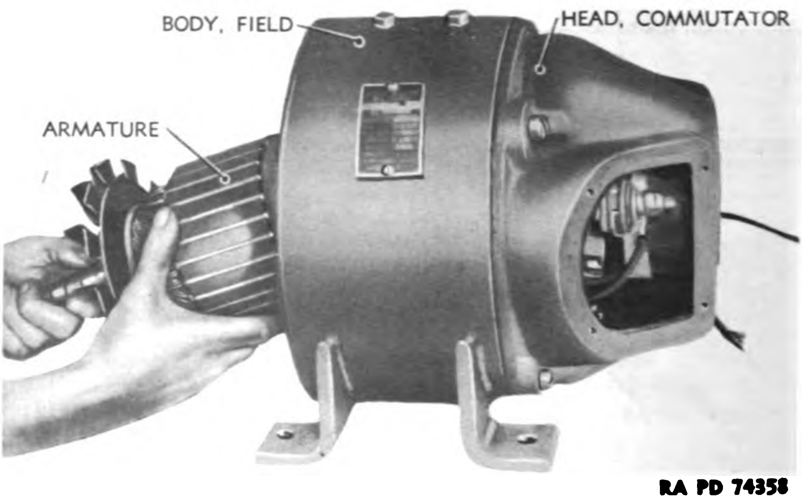

Figure 202 — Exciter Armature Removal

99. DISASSEMBLY (fig. 196).

a. Procedure.

(1) Take out socket-head set screw through pulley shank, and press out pulley.

(2) Take out screws holding end cover plates to commutator head.

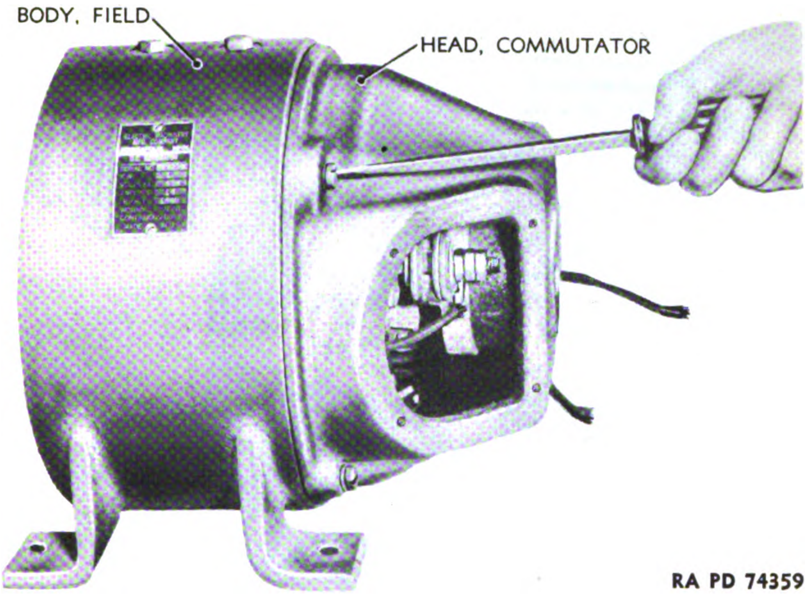

Figure 203 — Exciter Commutator Head Removal

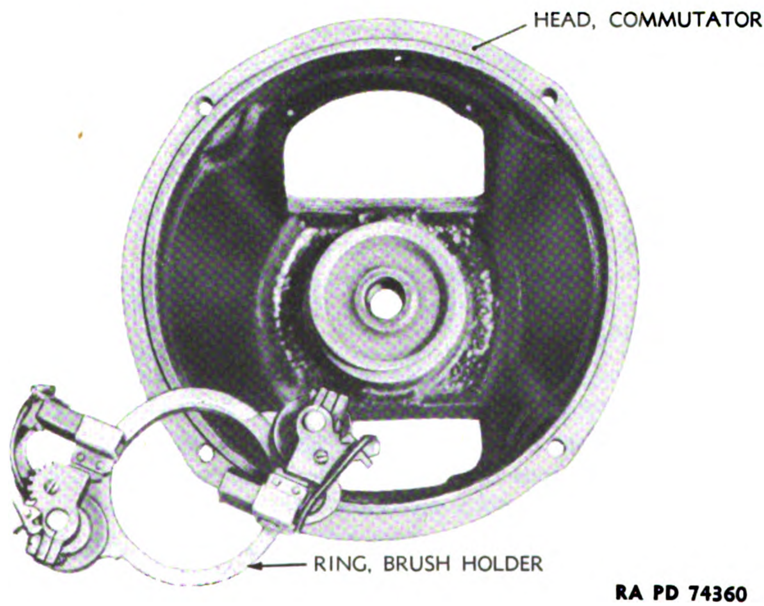

Figure 204 — Exciter Brush Holder Ring Removed

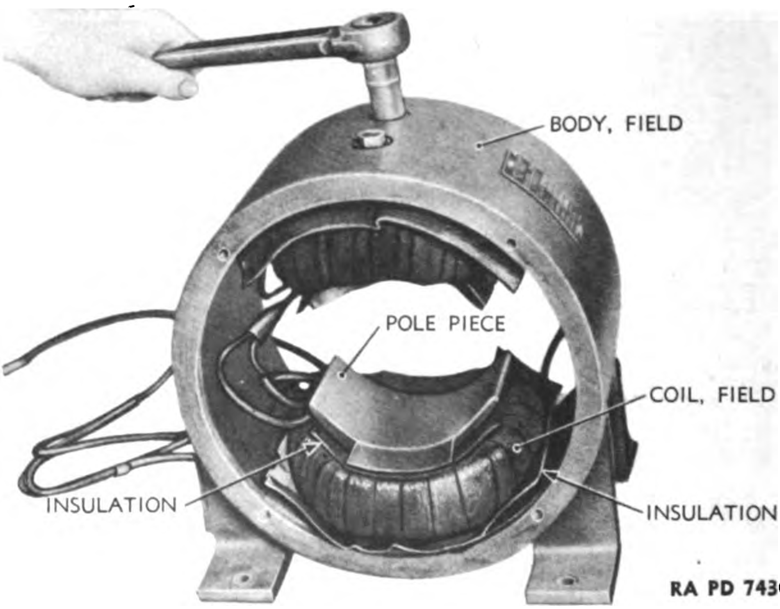

Figure 205 — Removing Exciter Field Coils

(3) Take out fillister-head screws, and remove cap (fig. 197). Slide retainer and spring washer from shaft (fig. 198).

(4) Take out four fillister-head screws, and remove pulley end hood (fig. 199).

(5) Take out fillister-head screws, and remove commutator end cap (fig. 200).

(6) Take out cotter pin securing castellated nut on end of armature shaft. Remove nut (fig. 201). Pull armature from commutator head (fig. 202).

(7) Take out the four fillister-head screws holding commutator head to field body, and remove commutator head (fig. 203).

(8) Take out nuts and washers holding field coil leads to brush-holder ring terminals. Take out fillister-head screws attaching brush-holder ring to commutator head, and remove ring (fig. 204).

(9) Press out bearings from commutator head and pulley end hood.

(10) Take out cap screws at top and bottom of field body (fig. 205), and remove field coils, pole pieces, and insulation (fig. 206).

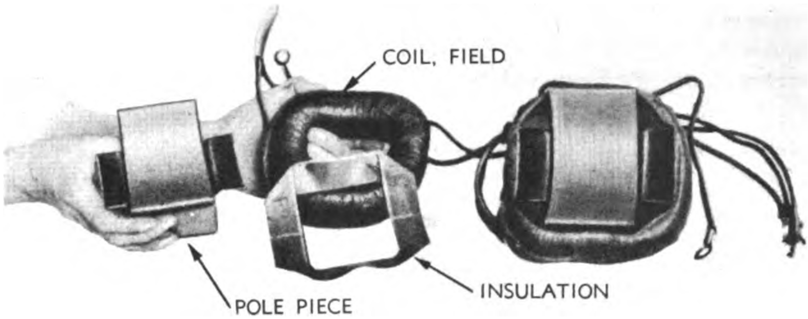

Figure 206 — Exciter Field Coil Assembly

100. INSPECTION.

a. Armature.

(1) GROUND. Place one probe of a test lamp on a commutator bar. Place the other probe on the armature shaft. If lamp lights, a ground is indicated. Failure of the lamp to light shows no ground to be present.

(2) SHORT CIRCUIT. Place armature in a growler. Turn on the growler. Move a steel strip or hacksaw blade slowly around the armature coils. Keep it parallel to the shaft. Turn off the growler and revolve the armature one-half turn in the growler. Turn on growler and test the other side of the armature. If the steel strip vibrates noticeably or is drawn to the laminations, a short circuit is indicated.

(3) COMMUTATOR BARS. Look for burs which might short-circuit two adjacent burs. Observe whether or not bars are scored.

(4) FAN. Inspect fan to see if it is bent or damaged.

(5) SHAFT. Inspect shaft to see if it is scored. Examine screw threads for burring or stripping.

b. Coils.

(1) OPEN CIRCUIT. Place one probe of test lamp on tip of coil to exciter brush wire. Touch other probe to tip of alternator lead "1." If the lamp lights, no open circuit is present. If the lamp fails to light, an open circuit is indicated. If an open circuit is indicated, test each coil separately.

(2) GROUND. Hold one probe against a bare lead from the coil. Place other probe against the pole piece. If lamp lights, a ground is present. Failure of lamp to light indicates coil is free of grounds.

(3) SHORT CIRCUIT. This test is made with coils connected in series. It can be made with coils installed or removed. Connect a 6-volt battery to exciter coil to commutator wire and to alternator lead "1." Using a 0- to 7½-volt voltmeter equipped with sharp pointed probes,

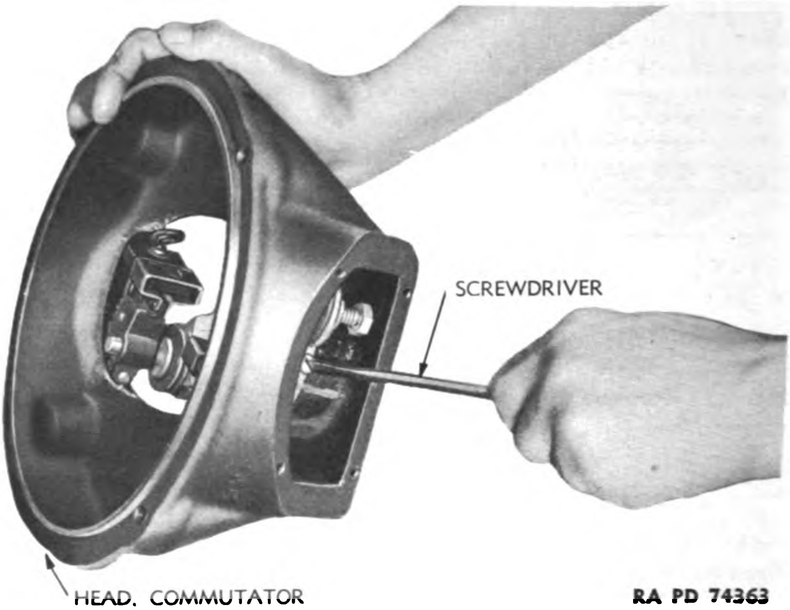

Figure 207 — Exciter Brush-holder Ring Insulation

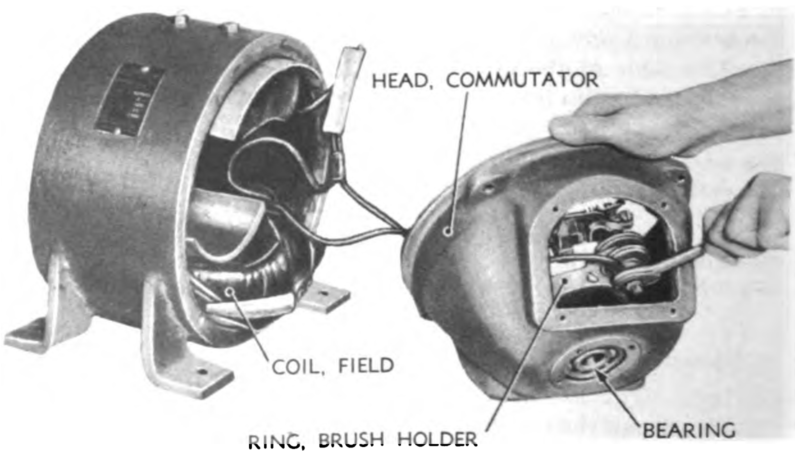

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Figure 208 — Connecting Exciter Field Coil Leads to Brush Ring

measure the voltage drop across each coil. Push one probe into one lead of coil. Push other probe into other lead of same coil. Observe reading on voltmeter. Repeat test on other coil. If the reading on one

coil is appreciably less than the other, a short circuit in that coil is indicated. If the reading is approximately equal, no short circuit is indicated. NOTE: If voltmeter hand moves in the wrong direction, reverse the probes.

c. **Brush-holder Ring Assembly.** Check ring, holders, springs, screws, and nuts for damage or signs of wear. Inspect brushes for wear. they should not be less than ¾ inch long.

d. **Bearings, Retainers, Washers.** Inspect for broken or worn bearings. Inspect retainers to see if they are bent or if welds have broken loose. Examine felt washers to see if they are worn, torn, or grease-soaked.

e. **Housing.** Inspect field body, commutator head, pulley end hood, end caps and covers for casting breaks or cracks, loose welds, or stripped threads.

101. MAINTENANCE AND REPAIRS.

a. **Armature.**

(1) OPEN CIRCUIT. If the cause of the open circuit is a wire pulled loose from a commutator bar, solder wire into slot in bar. Turn commutator bars down on a lathe and undercut the mica as described below. If break cannot be located, replace armature.

(2) SHORT CIRCUIT OR GROUND. If armature is grounded or short circuited, replace.

(3) SCORED COMMUTATOR BARS. Place armature in a lathe. Take a cut from the commutator bars. Make cut as light as possible but deep enough to remove all score marks. Hold a piece of PAPER, flint, Class B, No. 2/0 against the revolving bars to remove cutting tool marks. Remove armature from lathe. Then undercut mica to a depth of 0.025 inch between commutator bars.

(4) FAN. Carefully straighten, if bent. If broken, weld. Be careful to preserve balance.

(5) BEARINGS. Replace worn or broken bearing.

(6) SHAFT. If shaft is scored due to bearing failure, smooth off ridges with a fine mill file. Do not attempt to eliminate score mark. Smooth just enough so bearing can be pressed on. In case shaft is damaged enough to be undersize, replace armature assembly.

b. **Coils.** Replace any coils having an open circuit, ground, or short circuit.

c. **Brush-holder Ring Assembly.**

(1) BRUSH REPLACEMENT. Take out screws and lock washers holding end cover plate, and remove plate. Loosen screw on brush-holder ring, and turn ring until screw holding pigtail connection is

accessible. Remove screw, hold back spring lever arm, and remove brush. Attach pigtail connection of new brush to screw above brush-holder screw. Lift spring lever arm, set brush in place in holder, and drop lever on brush. Turn brush-holder ring until line marked on ring coincides with casting rib. Tighten screw on brush-holder ring. Attach end plate with screws.

(2) BRUSH SPRING REPLACEMENT. Take out screws holding end plate to exciter. Loosen screw holding brush-holder ring in position, and turn until brush-holder screw is accessible. Loosen the three nuts on the brush-holder screw, and remove screw and brush-holder assembly from yoke of brush-holder ring. Take out the round-head brass screw holding together the spring, the tension lever arm, a brass sleeve, and the brush-holder arm. Slip round-head brass screw through hole in ratchet, and assemble tension lever arm, sleeve, and a new spring, and screw down securely into the brush-holder arm. Install the screw in the brush-holder yoke with two fiber insulators on each side. Tighten the nuts until the screw is held firmly to the yoke.

d. **Housing.** A cracked or broken field body, commutator head, pulley end hood, or end cap must be replaced. Reweld broken welds. Stripped threads may be repaired by running a threading tool of the proper size through the hole.

102. ASSEMBLY.

a. **Procedure.**

(1) Insert pole piece through each field coil with insulation sheet in between. Bring each coil assembly into place in field body with another insulation sheet between and secure to body with cap screws. Carry leads marked F1, A1–, and A2+ outside field body through holes provided.

(2) Press shaft bearing into commutator head and pulley end cap.

(3) Slip brush-holder ring onto commutator head flange, turn ring until line on ring coincides with line on head casting rib, and then secure ring to flange with fillister-head screws (fig. 207).

(4) Attach the commutator head to the field body with four fillister-head screws, first connecting field coil leads A1 and A2 to the brush-holder ring terminals (fig. 208).

(5) Slide retainer ring on the armature shaft, commutator end, and insert armature through field body and commutator head.

(6) Slide felt washer and gasket over the armature shaft, set pulley end hood in position, and attach to field body with fillister-head screws.

(7) Screw castellated end nut on shaft, and secure with cotter pin. Install commutator end cap with fillister-head screws.

(8) Slide spring washer and retainer ring over shaft. Install pulley end cap with fillister-head screws.

(9) Install the two commutator end covers with fillister-head screws.

(10) Install key in shaft slot. Press pulley into place on shaft. Secure pulley to shaft with socket-head set screw.

103. INSTALLATION.

a. Procedure.

(1) Place exciter on plate and alternator. Install cap screws attaching exciter to adjustable plate on top of alternator.

(2) Use holding nuts on exciter plate posts to adjust exciter pulley to the proper position for installing belts from alternator pulley to exciter pulley. Install exciter belts.

(3) Connect exciter lead with "A-1" on its identification collar to post marked "A-1" on the terminal block. Connect leads marked "A-2" and "F" with terminal block posts marked the same.

CHAPTER 5

INSTRUMENT PANEL AND INSTRUMENTS

Section I

INSTRUMENT PANEL

104. DESCRIPTION (fig. 210).

a. The instrument panel is of sheet steel and is located behind the rear left-hand door of the unit, above the alternator. It is held in place against vertical supports welded to the center bow and the rear housing panel. The method of mounting varies somewhat with the different manufacturers. One method of mounting makes use of U-type steel clips bolted to brackets welded to the vertical supports (fig. 10), giving a spring action. In other cases, the panel is bolted directly to the supports.

b. The instrument panel brings together all the controls and gages necessary to the starting, stopping, and general operation and control of the unit (figs. 210 and 211), with the exception of the fuel gage. This is mounted on the instrument panel only on some make units. Figures 212 and 212A give a complete wiring diagram.

c. The general form of the instrument panel varies with the method of mounting and its manufacture. All of the panels illustrated vary in some details. On all units, the size of the central panel proper is the same, and the grouping of the instruments follows the same pattern.

105. REMOVAL.

a. **Procedure.**

(1) Trace alternator main leads from alternator to fuse panel, remove nuts securing leads, and remove leads. Trace remaining alternator leads to terminal block, take out connecting screws, and remove leads.

(2) Trace exciter leads from exciter to terminal block, take out connecting screws, and remove leads.

(3) Trace leads from 200-amp and 30-amp power receptacles to rear of instrument panel, and remove nuts and leads.

INSTRUMENT PANEL AND INSTRUMENTS

A—AMMETER, BATTERY CHARGING
B—GAGE, OIL PRESSURE
C—GAGE, TEMPERATURE
D—RECEPTICAL, LIGHT, 125 VOLT
E—METER, FREQUENCY OR TACHOMETER
F—SWITCH, IGNITION
G—RECEPTICAL, LIGHT, 6 VOLT
H—SWITCH, LIGHT, 6 VOLT
J—THROTTLE
K—CHOKE
L—BUTTON, STARTER
M—VOLTMETER, AC
N—RHEOSTAT, LOAD
O—RECEPTICAL, LIGHT, 6 VOLT
P—RHEOSTAT, LAMP DIMMING
Q—SWITCH, METER
R—AMMETER, AC
S—SWITCH, LIGHT, 125 VOLT
T—RECEPTICAL, 125 VOLT
U—SWITCH, LOAD

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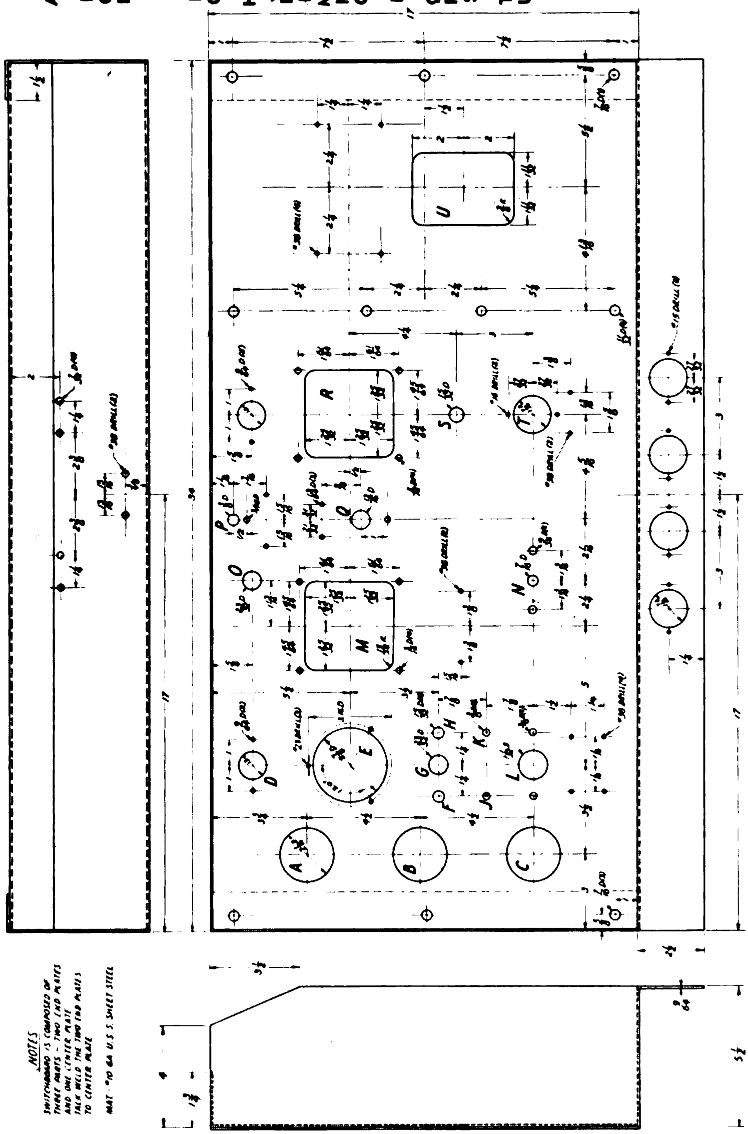

Figure 209 — Instrument Panel — Scale Drawing

CHAPTER 5

INSTRUMENT PANEL AND INSTRUMENTS

Section I

INSTRUMENT PANEL

104. DESCRIPTION (fig. 210).

a. The instrument panel is of sheet steel and is located behind the rear left-hand door of the unit, above the alternator. It is held in place against vertical supports welded to the center bow and the rear housing panel. The method of mounting varies somewhat with the different manufacturers. One method of mounting makes use of U-type steel clips bolted to brackets welded to the vertical supports (fig. 10), giving a spring action. In other cases, the panel is bolted directly to the supports.

b. The instrument panel brings together all the controls and gages necessary to the starting, stopping, and general operation and control of the unit (figs. 210 and 211), with the exception of the fuel gage. This is mounted on the instrument panel only on some make units. Figures 212 and 212A give a complete wiring diagram.

c. The general form of the instrument panel varies with the method of mounting and its manufacture. All of the panels illustrated vary in some details. On all units, the size of the central panel proper is the same, and the grouping of the instruments follows the same pattern.

105. REMOVAL.

a. **Procedure.**

(1) Trace alternator main leads from alternator to fuse panel, remove nuts securing leads, and remove leads. Trace remaining alternator leads to terminal block, take out connecting screws, and remove leads.

(2) Trace exciter leads from exciter to terminal block, take out connecting screws, and remove leads.

(3) Trace leads from 200-amp and 30-amp power receptacles to rear of instrument panel, and remove nuts and leads.

INSTRUMENT PANEL AND INSTRUMENTS

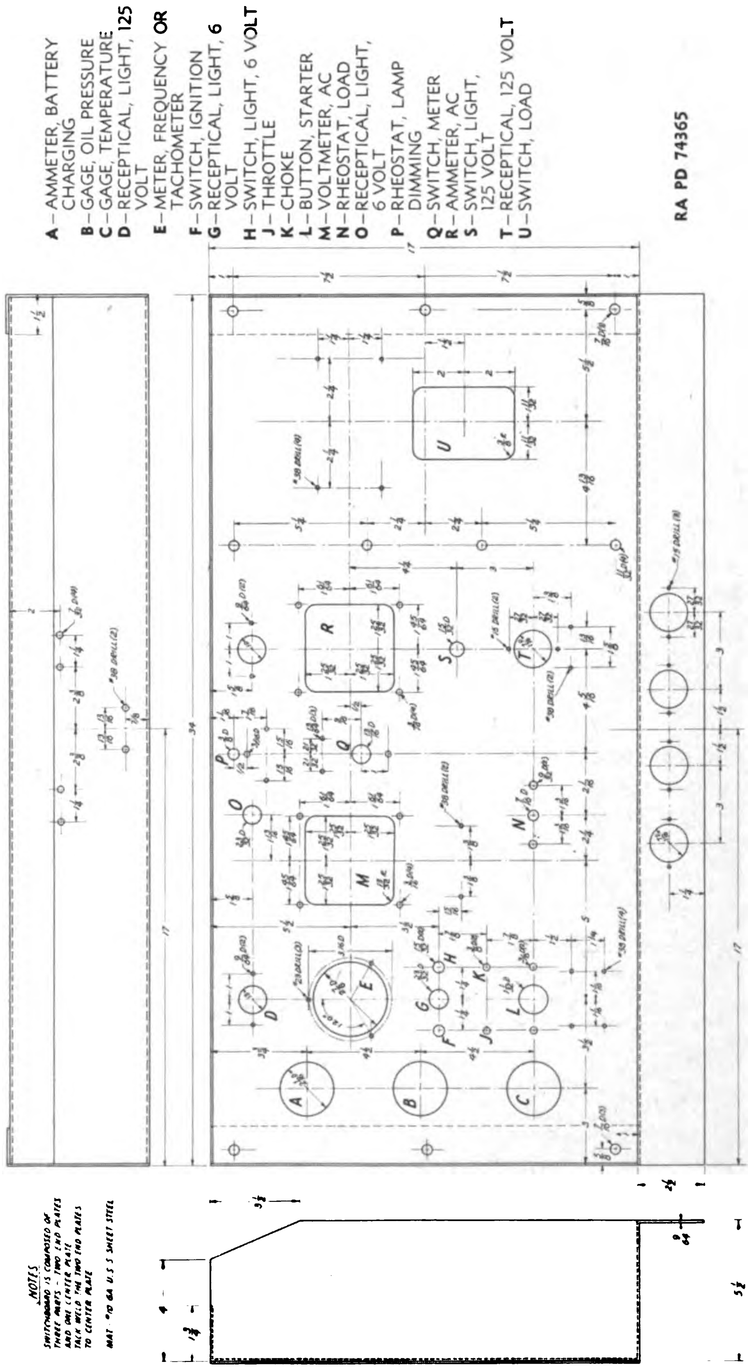

Figure 209 — Instrument Panel — Scale Drawing

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INSTRUMENT PANEL AND INSTRUMENTS

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(3) Trace leads from 200-amp and 30-amp power receptacles to rear of instrument panel, and remove nuts and leads.

INSTRUMENT PANEL AND INSTRUMENTS

A—AMMETER, BATTERY CHARGING
B—GAGE, OIL PRESSURE
C—GAGE, TEMPERATURE
D—RECEPTICAL, LIGHT, 125 VOLT
E—METER, FREQUENCY OR TACHOMETER
F—SWITCH, IGNITION
G—RECEPTICAL, LIGHT, 6 VOLT
H—SWITCH, LIGHT, 6 VOLT
J—THROTTLE
K—CHOKE
L—BUTTON, STARTER
M—VOLTMETER, AC
N—RHEOSTAT, LOAD
O—RECEPTICAL, LIGHT, 6 VOLT
P—RHEOSTAT, LAMP DIMMING
Q—SWITCH, METER
R—AMMETER, AC
S—SWITCH, LIGHT, 125 VOLT
T—RECEPTICAL, 125 VOLT
U—SWITCH, LOAD

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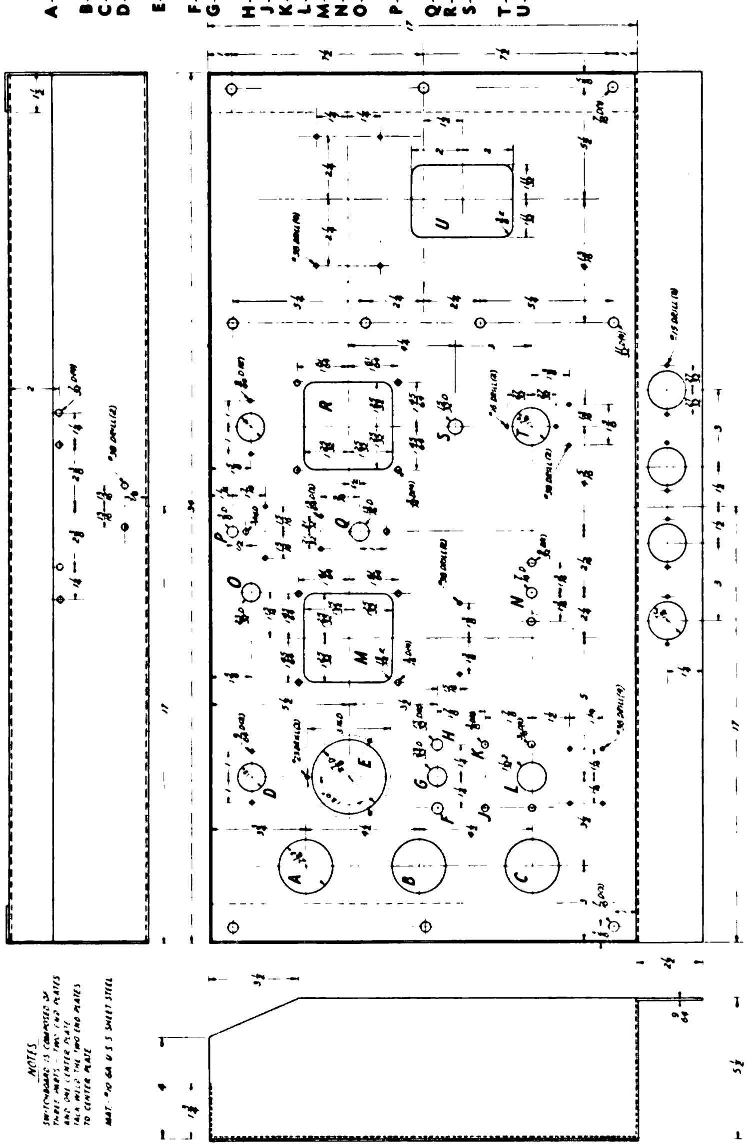

Figure 209 — Instrument Panel — Scale Drawing

CHAPTER 5

INSTRUMENT PANEL AND INSTRUMENTS

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a. The instrument panel is of sheet steel and is located behind the rear left-hand door of the unit, above the alternator. It is held in place against vertical supports welded to the center bow and the rear housing panel. The method of mounting varies somewhat with the different manufacturers. One method of mounting makes use of U-type steel clips bolted to brackets welded to the vertical supports (fig. 10), giving a spring action. In other cases, the panel is bolted directly to the supports.

b. The instrument panel brings together all the controls and gages necessary to the starting, stopping, and general operation and control of the unit (figs. 210 and 211), with the exception of the fuel gage. This is mounted on the instrument panel only on some make units. Figures 212 and 212A give a complete wiring diagram.

c. The general form of the instrument panel varies with the method of mounting and its manufacture. All of the panels illustrated vary in some details. On all units, the size of the central panel proper is the same, and the grouping of the instruments follows the same pattern.

105. REMOVAL.

a. **Procedure.**

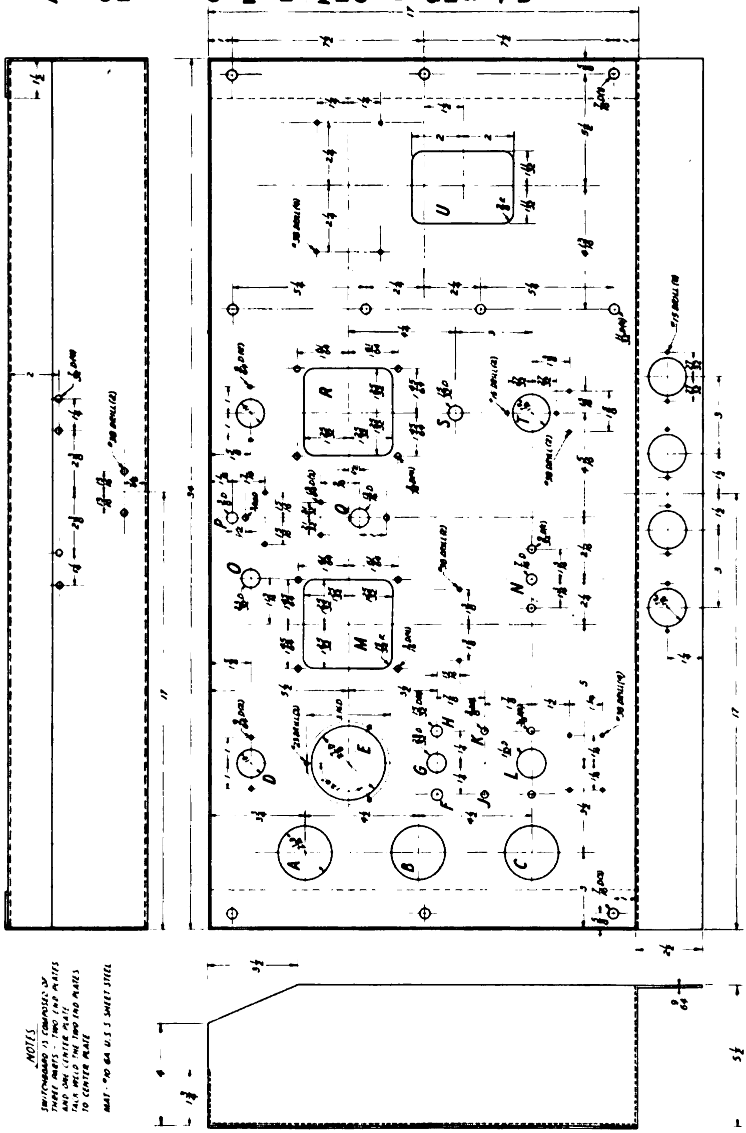
(1) Trace alternator main leads from alternator to fuse panel, remove nuts securing leads, and remove leads. Trace remaining alternator leads to terminal block, take out connecting screws, and remove leads.

(2) Trace exciter leads from exciter to terminal block, take out connecting screws, and remove leads.

(3) Trace leads from 200-amp and 30-amp power receptacles to rear of instrument panel, and remove nuts and leads.

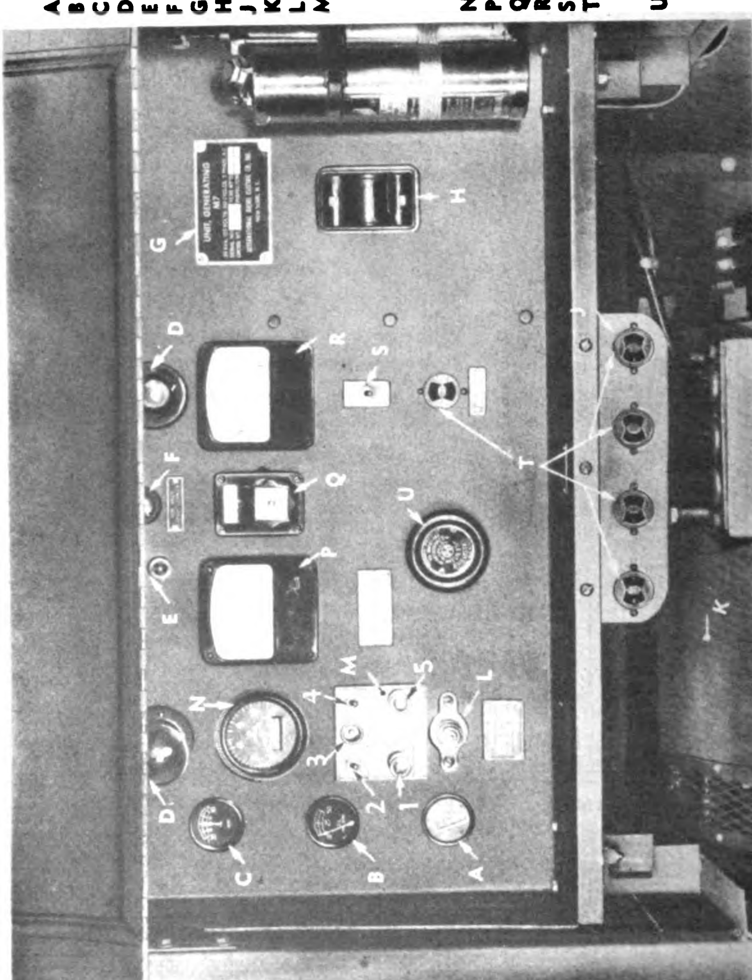
INSTRUMENT PANEL AND INSTRUMENTS

A—AMMETER, BATTERY CHARGING
B—GAGE, OIL PRESSURE
C—GAGE, TEMPERATURE
D—RECEPTICAL, LIGHT, 125 VOLT
E—METER, FREQUENCY OR TACHOMETER
F—SWITCH, IGNITION
G—RECEPTICAL, LIGHT, 6 VOLT
H—SWITCH, LIGHT, 6 VOLT
J—THROTTLE
K—CHOKE
L—BUTTON, STARTER
M—VOLTMETER, AC
N—RHEOSTAT, LOAD
O—RECEPTICAL, LIGHT, 6 VOLT
P—RHEOSTAT, LAMP DIMMING
Q—SWITCH, METER
R—AMMETER, AC
S—SWITCH, LIGHT, 125 VOLT
T—RECEPTICAL, 125 VOLT
U—SWITCH, LOAD



RA PD 74365

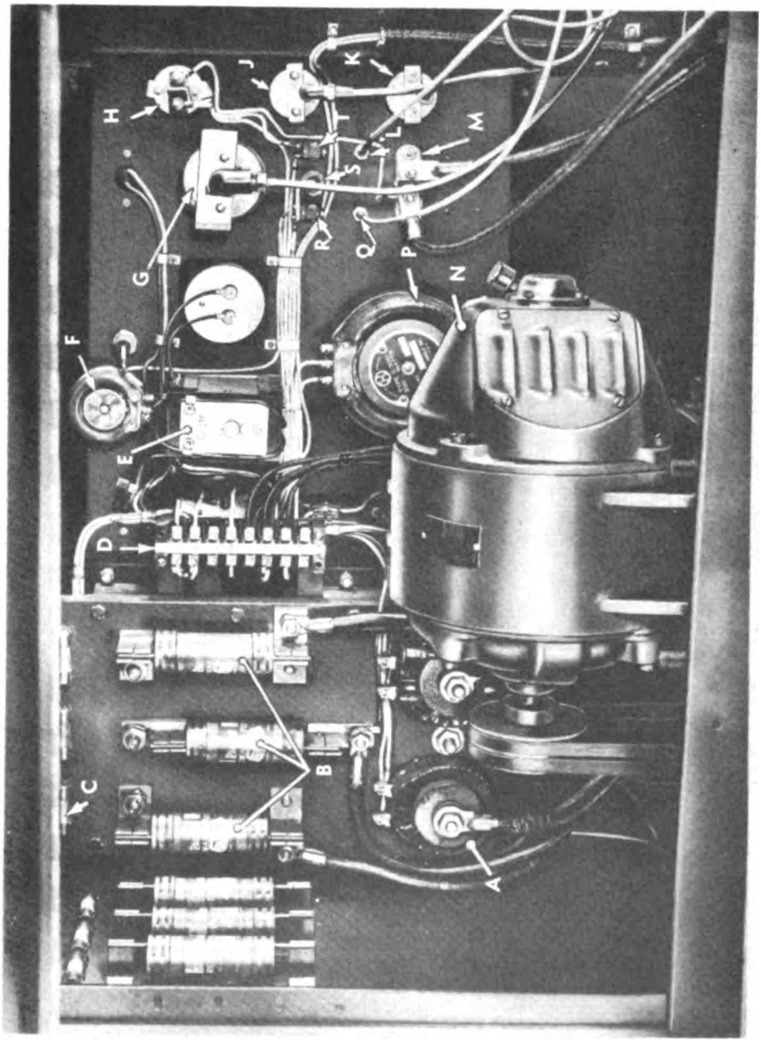
Figure 209 — Instrument Panel — Scale Drawing



A — GAGE, TEMPERATURE
B — GAGE, OIL PRESSURE
C — AMMETER, BATTERY CHARGING
D — BULB, 125 V.
E — LIGHT, 6 V.
F — RHEOSTAT, LAMP DIMMING
G — NAMEPLATE, UNIT
H — SWITCH, LOAD
J — APRON, SWITCHBOARD
K — ALTERNATOR
L — BUTTON, STARTER
M — CONTROL GROUP
1 — THROTTLE
2 — SWITCH, IGNITION
3 — RECEPTACLE, 6 V.
4 — SWITCH, LIGHT, 6 V.
5 — CHOKE
N — TACHOMETER
P — VOLTMETER
Q — SWITCH, METER
R — AMMETER
S — SWITCH, 125 V. LIGHT
T — RECEPTACLES, T-SLOT FOR 125 V. TROUBLE LIGHT AND POWER TOOLS
U — RHEOSTAT, FIELD

RA PD 74366

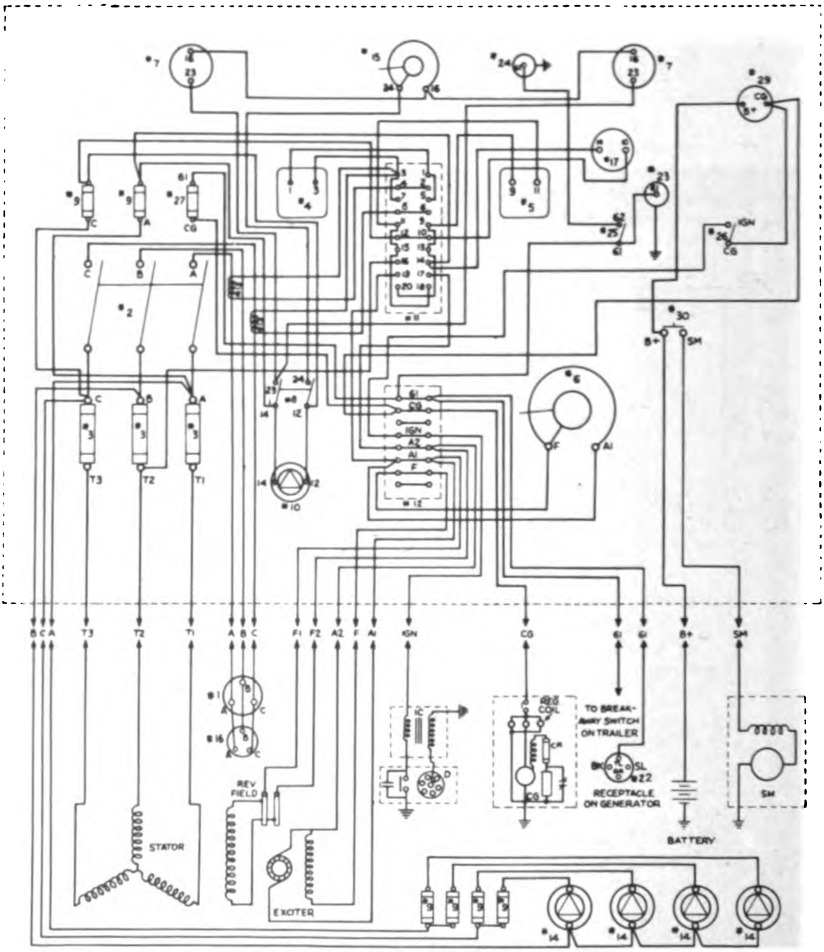
Figure 210 — Instrument Panel



A — TRANSFORMER
B — FUSE, 200 AMP.
C — FUSE, 30 AMP.
D — BLOCK, TERMINAL
E — SWITCH, METER
F — RHEOSTAT, LAMP DIMMING
G — TACHOMETER
H — AMMETER, BATTERY CHARGING
J — GAGE, OIL PRESSURE
K — GAGE, TEMPERATURE
L — THROTTLE
M — BUTTON, STARTER
N — EXCITER
P — RHEOSTAT, FIELD
Q — CHOKE
R — SWITCH, LIGHT, 6 V.
S — RECEPTACLE, 6 V.
T — SWITCH, IGNITION

RA PD 74367

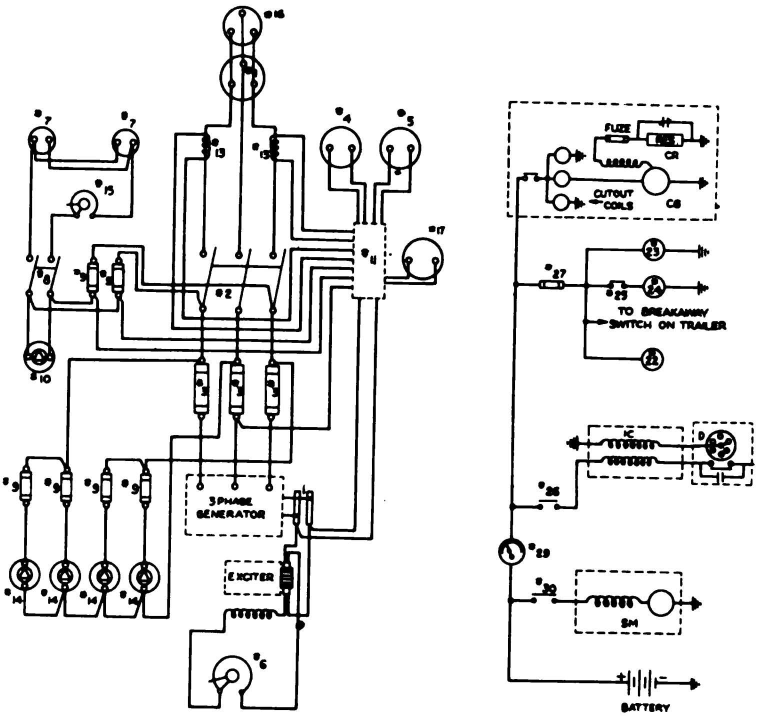
Figure 211 — Instrument Panel — Rear View



RA PD 15238

Figure 212 — Wiring Diagram

INSTRUMENT PANEL AND INSTRUMENTS



125 VOLT AC CIRCUIT

1- LOAD RECEPTACLE
2- LOAD SWITCH
3- FUSE-200 AMPS
4- AMMETER
5- VOLTMETER
6- RHEOSTAT
7- LIGHTS
8- SWITCH, 125 V. LIGHTS
9- FUSES
10- RECEPTACLE, EXTENSION CORD
11- METER SWITCH
12- TERMINAL BLOCK
13- CURRENT TRANSFORMERS
14- RECEPTACLE, POWER TOOLS
15- RHEOSTAT, LIGHT DIMMING,
200 OHM, 1 TAPER, 1 AMP.
16- LOAD RECEPTACLE,
30 AMPS, C80109
17- FREQUENCY METER

6 VOLT BATT. CIRCUIT

22- RECEPT FOR BRAKES AND LIGHTS
23- RECEPT FOR EXTENSION CORD
24- LIGHT
25- LIGHT SWITCH
26- IGNITION SWITCH
27- FUZE
29- AMMETER
30- STARTER SWITCH
CG- CHARGING GENERATOR
CR- CHARGING VOLTAGE REGULATOR
IC- IGNITION COIL
D- DISTRIBUTOR
SM- STARTER MOTOR

SMALL WIRE COLOR CODE

LINE A - RED
LINE B - GREEN
LINE C - BLUE
EXCITER - A1 BLACK
+A2 WHITE
6 VOLTS YELLOW

RA PD 15238A

Figure 212A — Wiring Diagram

(4) Locate lead at fuel tank gage unit. Remove connecting screw and lead.

(5) Trace lead from brake receptacle to terminal block, and remove leads.

(6) At back of starter button on instrument panel, remove nuts holding leads to switch, and remove leads.

(7) Remove tachometer cable by unscrewing swivel nut from connector elbow at back of tachometer.

(8) Trace ignition coil and battery-charging generator leads to terminal block, unscrew connecting screw, and remove leads.

(9) Disconnect oil line flare tube fitting at oil pressure gage.

(10) Trace temperature indicator line from instrument panel to engine. Unscrew and remove temperature indicator bulb from cylinder head.

(11) Disconnect throttle and choke wires from carburetor.

(12) Remove instrument panel. (Omit this step when removing housing to work on engine or alternator.) NOTE: The procedure of actual panel removal will vary with the make of unit.

106. DISASSEMBLY.

a. Disassembly of the instrument panel includes removing all of the instruments, switches, and receptacles. Detailed information pertaining to the removal of these units is found in chapter V, section II, of this manual, and in section XVI of TM 9-618.

107. INSPECTION AND REPAIR.

a. **Procedure.**

(1) Visually inspect the panel for bent or broken places. Straighten bends. Weld cracks or breaks, and file down smooth.

(2) Inspect all welds, and if necessary, reweld.

108. ASSEMBLY.

a. Mount all instruments, switches, and receptacles on to instrument panel. Detailed information pertaining to the installation of these units is found in chapter V, section II, of this manual, and in section XVI of TM 9-618.

109. INSTALLATION.

a. Procedure.

(1) Install instrument panel. NOTE: Method of installing panel will vary with make of unit.

(2) Connect oil line at oil pressure gage fitting.

(3) Bring lead from ignition coil to terminal block, and connect at post marked "IGN" on identification strip. Bring lead from battery-charging generator to terminal block, and connect at post marked "CG."

(4) Connect tachometer cable (if tachometer is on panel).

(5) Attach lead from starting motor to starter switch connection on rear of instrument panel.

(6) Screw bulb on temperature indicator line into tapped hole in cylinder head.

(7) Fasten throttle and choke wires through support bracket. Carry choke wire taut through binding post on choke arm, and tighten screw. Hold throttle valve lever forward, and connect wire to binding post on arm.

(8) Connect lead from terminal marked "TA" on terminal block, to the fuel tank gage unit. (This applies only to those generating units equipped with electric fuel gage.)

(9) Attach power receptacle leads to studs at bottom of instrument panel. Leads "A" go to the right stud. Leads "B" go to the center stud. Leads "C" go to the left stud.

(10) Bring lead from brake receptacle to terminal block, and connect at screw marked "61."

(11) Connect exciter lead with "A-1" on its identification collar to post marked "A-1" on the terminal block. Connect leads marked "A-2" and "F" with terminal block posts marked "A-2" and "F" respectively.

(12) Connect alternator main lead marked "T-2" to middle fuse on junction box. Leads marked "T-1" and "T-3" connect to the other fuses, interchangeably. The two small, or field, leads of the generator go to the terminal block. Fasten lead "F-1" to terminal block post "A-1," and lead "F-2" to terminal block post "A-2."

Section II

INSTRUMENTS AND SWITCHES

110. TROUBLE SHOOTING.

a. Fails to Register.

Possible Cause	Possible Remedy
Defective connection to instrument.	Repair connection.
Defective mechanism.	Replace mechanism or instrument.

b. Registers Incorrectly.

Possible Cause	Possible Remedy
Out of adjustment.	Adjust or replace instrument.
Defective connection to instrument.	Repair connection.
Defective mechanism.	Replace mechanism or instrument.

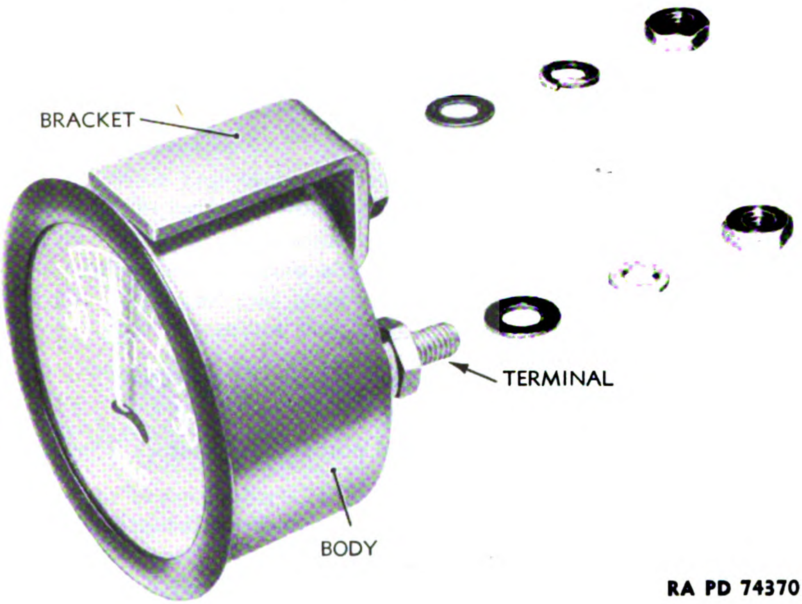


Figure 213 — Battery-charging Generator Ammeter

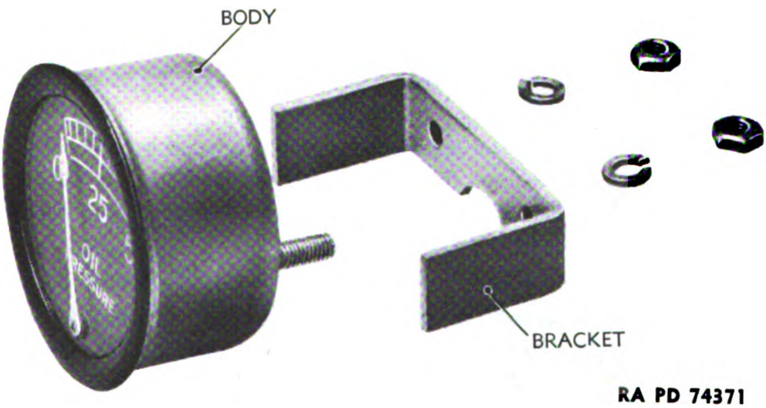


Figure 214 — Oil Pressure Gage

111. BATTERY-CHARGING GENERATOR AMMETER (fig. 213).

a. Description.

(1) Of standard automotive design, the battery-charging generator ammeter registers up to 30 amperes of current flow in either direction through it. Current passing through a coil sets up a magnetic field which

attracts or repels a piece of iron. The iron is linked to a hand which indicates the direction of the current (charge or discharge), and the amount of current in amperes.

(2) The function of the ammeter is to register rate of charge or discharge in engine battery circuit.

b. **Removal.**

(1) Remove nuts holding bracket against the rear of the panel, and remove bracket clips.

(2) Take off stop nuts attaching leads, and remove leads.

(3) Remove ammeter.

c. **Disassembly.**

(1) Remove nut and plain washer from each terminal.

(2) Pry bezel from ammeter case.

(3) Lift ammeter mechanism and porcelain insulators from case.

d. **Inspection and Repair.**

(1) Connect leads from posts of a 6-volt dry cell battery to terminal posts of ammeter. Note ammeter reading.

(2) Reverse leads on ammeter terminal posts. Observe ammeter reading.

(3) Repeat steps (1) and (2), above, using an ammeter known to be accurate. If readings between the two ammeters differ appreciably, replace ammeter mechanism.

(4) Replace glass in bezel, if broken.

(5) Replace insulators if damaged.

e. **Assembly.**

(1) Place the porcelain insulators on the terminal posts, and insert mechanism into case.

(2) Slide fiber insulator on terminal posts in back of case. On each post install terminal, flat washer and nut.

(3) Tap bezel and glass assembly in place with hammer.

f. **Installation.** Secure ammeter to instrument panel by fastening bracket over studs with nuts. Attach two wires marked "CG" to right connection, and wire marked "B+" to left connection.

112. OIL PRESSURE GAGE (fig. 214).

a. **Description.**

(1) The oil pressure gage indicates the pressure at which the oil pump is forcing the oil through the oil lines. As the pump builds up pressure, oil is forced through the oil pressure gage line (copper tube) to the gage. As the oil is forced into the mechanism, which consist of a flattened crescent-shaped tube linked to the indicator hand, the tube

tends to straighten, thereby moving the hand across the dial. The gage indicates up to 50 pounds per square inch pressure.

(2) With the engine running at 1,200 rpm, the oil pressure gage should indicate 25 pounds pressure if the engine is fully warmed up.

b. Disassembly.

(1) With gage removed from panel, remove oil pressure gage line elbow from gage.

(2) Remove oil pressure gage nipple nut and flat washer from oil pressure gage nipple.

(3) Pry bezel and glass assembly from case.

(4) Lift movement from case.

c. Inspection and Repair.

(1) Clean parts of oil pressure gage in dry-cleaning solvent, and dry with compressed air.

(2) Check functioning of gage mechanism with that of a gage known to be good. Use a "T" connection. Replace gage, if defective.

(3) Replace glass in bezel, if broken.

(4) Inspect case, studs, threads, etc. Repair or replace if damaged.

d. Assembly.

(1) Place oil pressure gage mechanism in case, and tap bezel and glass assembly into case.

(2) Install oil pressure gage nipple flat washer and nut on oil pressure gage nipple.

113. TEMPERATURE INDICATOR GAGE (fig. 215).

a. Description. The temperature gage on the instrument panel indicates the temperature of the cooling water in the engine. This should be maintained at between 160 F and 190 F, by adjusting the radiator doors.

b. Removal.

(1) Unscrew temperature indicator bulb from cylinder head.

(2) Take off nuts holding bracket to panel, and remove gage.

c. Disassembly. The temperature gage should not be disassembled.

d. Inspection and Repair. With the gage attached to the temperature line, insert the bulb at the end of the line in a pan of boiling water. If the hand on the gage moves just past the 210 degree mark (212 F) the gage is indicating correctly. If the gage registers incorrectly, it should be replaced. Repairs should not be attempted.

e. Installation.

(1) Secure gage to instrument panel by fastening bracket over studs with nuts.

(2) Install bulb at end of gage line in tapped hole in cylinder head.

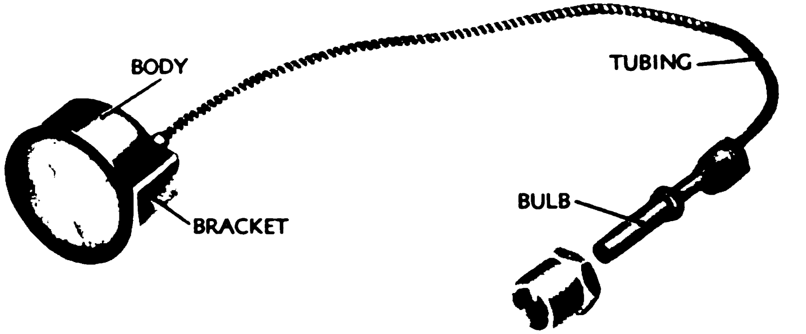


Figure 215 — Water Temperature Gage

114. ELECTRIC FUEL GAGE.

a. **Description.** The fuel gage is electrically connected to a float-operated unit in the fuel tank. This unit consists of a float arm and variable resistor. The resistor is connected in series with the fuel gage across the 6-volt battery circuit, and the reading of the gage is therefore dependent upon the fuel level of the tank. The capacity of the fuel tank is 26 gallons.

b. **Removal.** NOTE: Before removal, check performance (subparagraph c, below). Remove nuts, leads, and bracket from rear of gage at back of instrument panel, and remove gage.

c. **Disassembly and Inspection.** Repairs to the fuel gage should not be attempted. If action is faulty or the gage has been injured, a new gage should be installed. With the gage installed, performance may be checked by adding a known quantity of fuel to the tank, and noting the change in indication.

d. **Installation.**

(1) Secure gage to instrument panel by fastening bracket over gage studs with nuts.

(2) Attach two leads marked "IGN" to left connection, attach lead marked "TA" to right-hand connection, and secure each with a fiber washer and a nut.

115. TACHOMETER.

a. **Description.**

(1) The sweep hand on the tachometer indicates, on the large dial, the revolutions per minute of the engine in hundreds of revolutions. At the bottom of the dial is an odometer which records the total number of revolutions of the engine, also in hundreds of revolutions.

(2) The engine governor should be adjusted to maintain a constant running speed of 1,200 rpm.

b. Disassembly, Inspection, and Repair.

(1) The tachometer is not to be disassembled.

(2) If it is suspected that the action of the tachometer is faulty, it should be removed, and one known to be good installed. If the replacement tachometer indicates differently under the same conditions, the original instrument should not be used.

116. FREQUENCY METER.

a. Description.

(1) The frequency meter indicates the cycles of the alternating current generated. The meter consists of a number of reeds above an indicating scale and an electromagnetic coil, fastened to the base of the meter. Each reed is made to have a desired period of vibration. The reeds are then fastened in order, to the base, according to their vibration frequency, and given a final adjustment by hand. Any vibrations from the coil are transmitted to the reeds.

(2) The coil in the frequency meter is connected to a phase of the circuit and vibrates with the electrical impulses of the alternating current generated. Since each reed will vibrate appreciably with only one frequency, the reed having the same frequency as the current alternations will respond by vibrating through an arc, giving the appearance of a long line. At 60 cycles, which is the proper frequency with the engine at 1,200 rpm, the reed above the "60" line on the scale will show maximum vibration while adjacent reeds will be vibrating in a lesser degree.

b. Removal.

(1) Take off lock nuts and spring washers, and remove leads.

(2) Remove nuts and screws holding meter to panel, and remove meter.

c. Inspection and Repair.

(1) From an unvarying source of alternating current, 60 cycle and approximately 110 volts, connect leads to frequency meter terminals. Observe reading. Connect same leads to a frequency meter of known accuracy. Observe reading. Replace frequency meter being tested if readings differ appreciably from that of the known good frequency meter, or if frequency meter is damaged.

d. Installation.

(1) Attach meter to panel with screws, lock washers, and nuts.

(2) Bring leads marked "10" and "14" to rear of frequency meter. Attach to terminals, and secure with stop nuts.

NOTE: Some units have frequency meter hooked up with leads from voltmeter.

117. VOLTMETER.

a. **Description.** The a-c voltmeter on the instrument panel indicates the voltage of the exciter current and the voltage of the current generated by the unit, which is normally 125 volts. At this point on the dial is a red line. For procedure in obtaining these readings, see TM 9-618.

b. **Removal.**

(1) Hold elastic stop nuts on back of voltmeter, and unscrew the four corner bolts on face of voltmeter. On some units, removing these bolts will also release clips holding leads to panel.

(2) Take elastic stop nuts from the connections on the back of the voltmeter, remove leads and voltmeter.

c. **Inspection and Repair.** From an unvarying source of approximately 110-volt, 60-cycle alternating current, attach lead to each voltmeter terminal. Observe voltmeter reading. Connect another voltmeter known to be accurate across the voltmeter terminals. Observe the reading. If voltmeter being tested registers differently from the known good voltmeter, replace the voltmeter.

d. **Installation.**

(1) Place voltmeter in instrument panel, insert bolts through holes, install clips, if any, holding leads to panel, and install nuts.

(2) To the right connection post attach lead marked "11." To the left post attach lead "9," and install nuts.

e. **Adjustment.**

NOTE: With engine of unit not running, turn voltmeter adjusting screw to right or left until indicating hand points to zero.

118. AMMETER.

a. **Description.** The ammeter indicates the amperage of the current delivered in the phases of the circuit.

b. **Removal.**

(1) Hold elastic stop nuts on back of panel, and unscrew the four corner screws on the face of the ammeter. Removing these screws from some units will release a 3-wire clip held by each of the screws on the right side of the meter.

(2) Take elastic stop nuts from the terminals on the back of the ammeter, remove leads, and remove ammeter.

c. **Inspection and Repair.** From a source of approximately 30-amperes, 60-cycle alternating current, attach lead to each ammeter

terminal. Observe ammeter reading. Connect another ammeter known to be accurate across the ammeter terminals. Observe the reading. If ammeter being tested registers differently from the known good ammeter, replace the ammeter.

d. **Installation.**

(1) Place ammeter in instrument panel, insert bolts through holes, install clips (if any) holding leads to panel, and install nuts.

(2) Attach lead marked "1" to left terminal, and lead marked "3" to right with connecting nuts.

119. METER SWITCH (fig. 216).

a. **Description.** To check the voltage of the exciter, the amperage of the current being delivered to each of the three phases of the connected load, and the voltage between phases, the meter switch is provided. The method of checking the voltage and amperage is described in TM 9-618.

b. **Removal.**

(1) Remove elastic stop nuts from all connection posts, and remove all leads.

(2) Take out vertical screw through the shank of the knob, and remove knob.

(3) Unscrew four flat-head screws in faceplate, and remove plate. Remove front plate from face of panel by taking out three round-head screws from plate to hexagonal posts. The meter switch body can now be lifted from the rear of the panel.

c. **Inspection and Repair.**

(1) Inspect all parts of body for cracks or breaks. If any are found, replace switch.

(2) Slide out side panels (fig. 217). Inspect all contacts, fixed and movable for defects or for signs of burning. Replace any contacts not found in good condition (figs. 218 and 219).

(3) Install handle in position and rotate the handle to the various positions. At the same time rotate the handle of a meter switch known to be good. Compare the action of the cam on the two switches. If the rotation does not produce identical action of the movable contacts in the two switches, the switch being tested is at fault and should be replaced.

d. **Installation.**

(1) Replace side panels, and place connection block in position at rear of instrument panel with shaft projecting through panel. Carry connection plate over shaft on front of panel, and install switch with screws through plate, panel, and connection block.

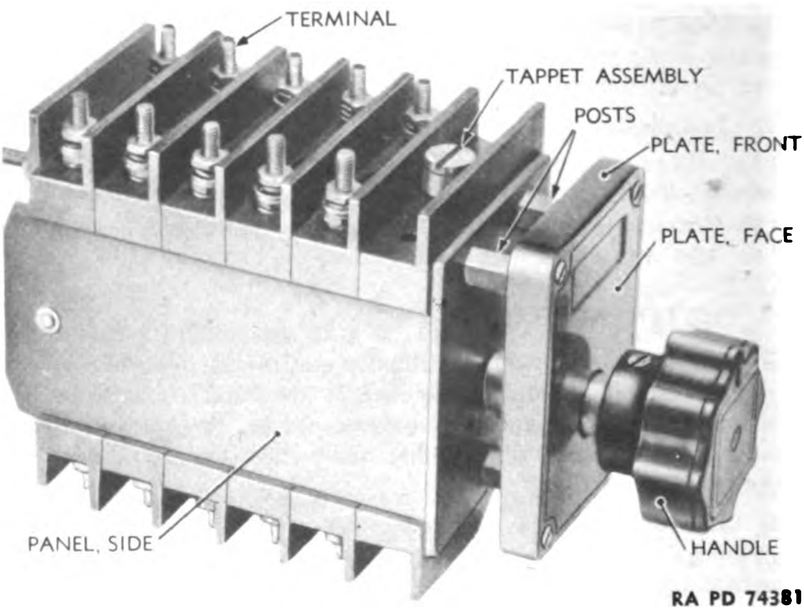


Figure 216 — Meter Switch

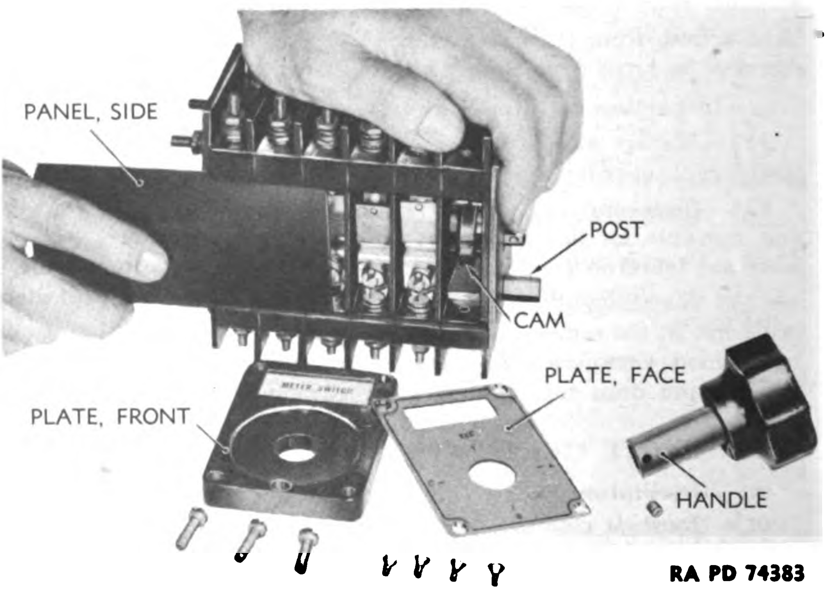


Figure 217 — Meter Switch Side Panel Removal

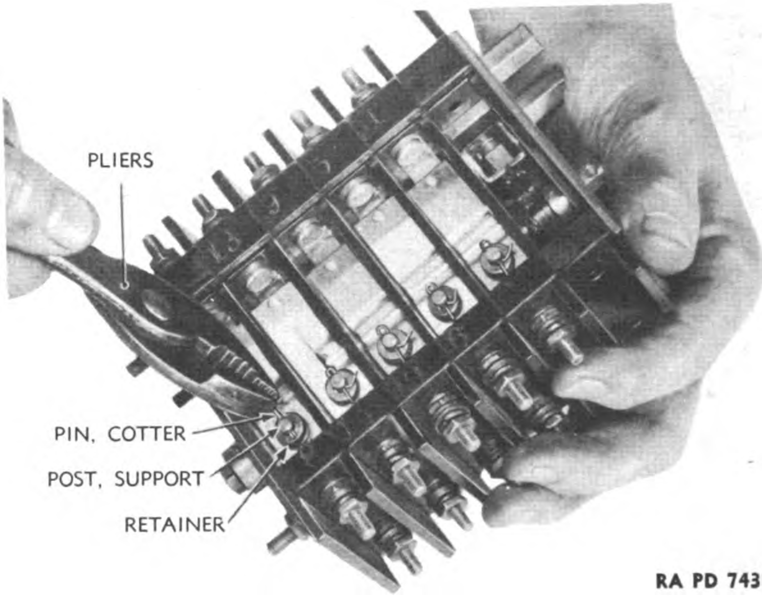


Figure 218 — Removing Cotter Pin from Movable Contact

(2) Cover mounting plate with faceplate, put name card and cover in proper position, and connect plates with corner screws. Slide knob over shaft with tapped pole through shank centered on hole in shaft. Secure knob to shaft with screw.

(3) Connect leads to connection posts marked identically with the leads by installing elastic stop nuts over the lead lugs.

120. IGNITION SWITCH.

a. **Description.** The ignition switch is toggle type, single pole, single throw. It controls the current in the ignition system and electric fuel gage.

b. **Inspection and Repair.** A faulty ignition switch cannot be repaired and must be replaced.

121. 6-VOLT LIGHT SWITCH.

a. **Description.** The 6-volt light switch is toggle type, single pole, single throw. It controls the 6-volt light which is used to furnish illumination when the unit is not running.

b. **Inspection and Repair.** This switch cannot be repaired, and if faulty, must be replaced.

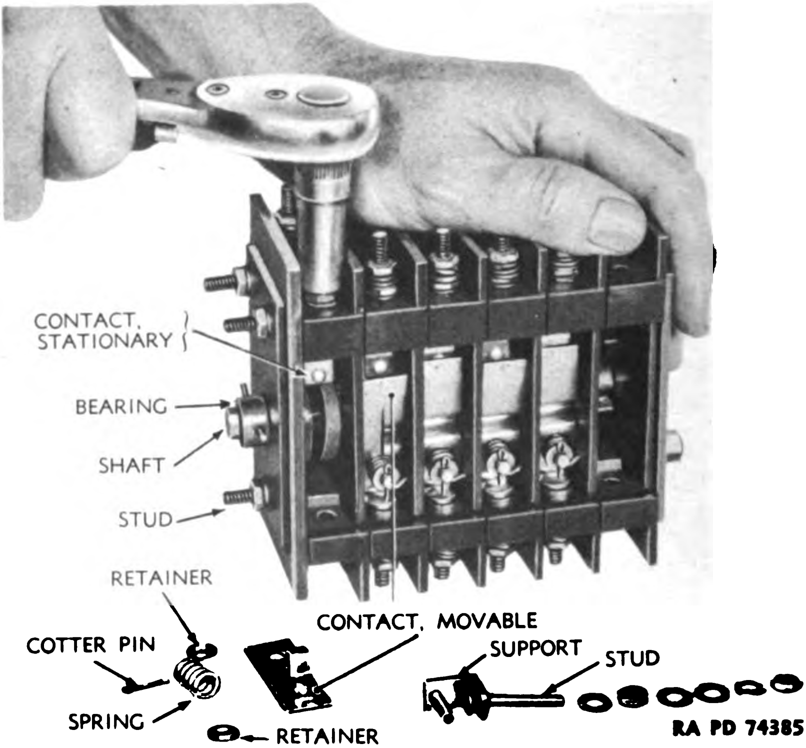


Figure 219 — Stationary Contact Removal

122. 125-VOLT LIGHT SWITCH.

a. **Description.** The 125-volt light switch is toggle type, double pole, single throw. This switch throws on the 125-volt lamps at the top of the panel.

b. **Inspection and Repair.** This switch cannot be repaired, and if faulty, must be replaced.

123. STARTER SWITCH (fig. 220).

a. **Description.** The engine starter, or cranking switch, is mounted on the left side of the instrument panel, directly below the throttle and choke knobs. It is a "push" switch of the conventional automotive type.

b. **Disassembly.**

(1) Remove starter switch.

(2) With starter switch removed from the panel, take out round-head screw which goes through one side plate (fig. 221), insulation

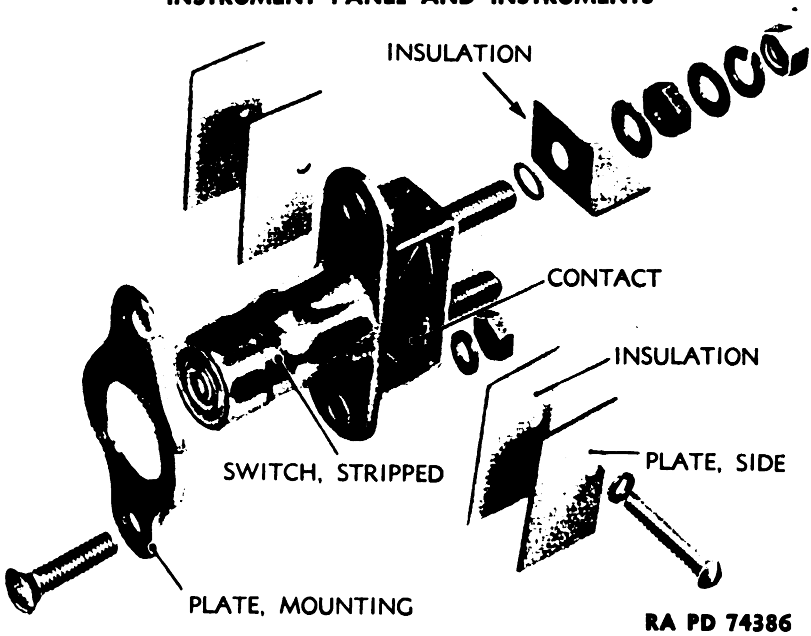


Figure 220 — Starter Switch — Exploded View

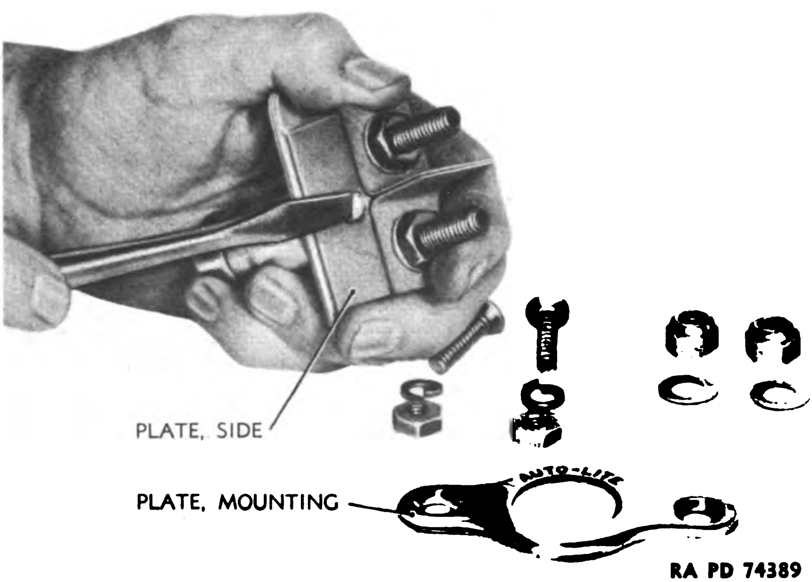


Figure 221 — Removing Starter Switch Side Plates

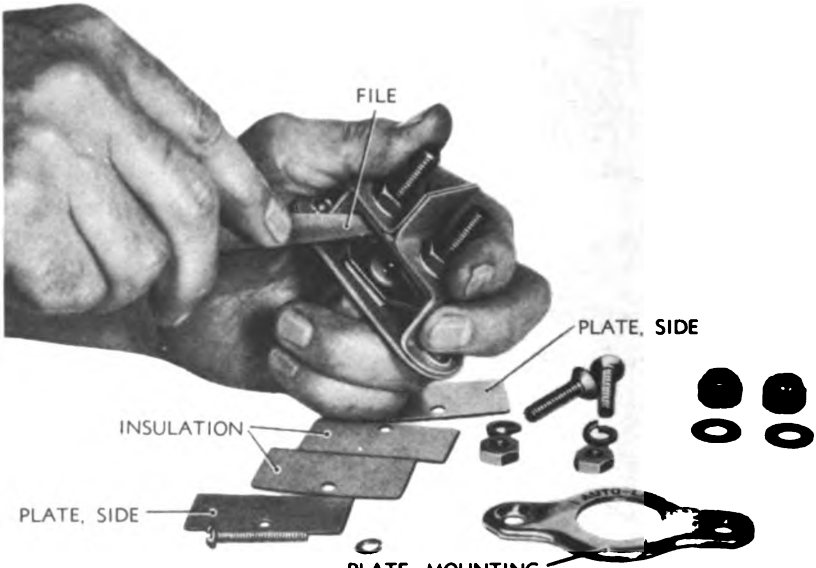


Figure 222 — Brightening Starter Switch Contacts

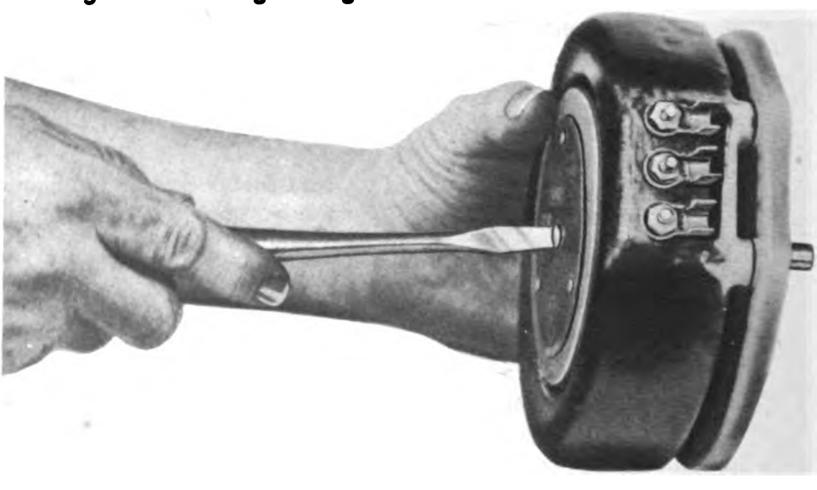


Figure 223 — Removing Field Rheostat Contact Assembly from Shaft

plates, and into a tapped hole in the opposite side plate. Remove plates.

c. Inspection and Repair.

(1) With plates removed, hold switch in hands, and push down on the switch plunger. Note whether or not the contact yoke makes

a good contact with the stud plates. If the spring does not work or if contacts are broken, replace switch.

(2) Observe the condition of the contact yoke and the stud plates. If they are not bright and clean, brighten them with a narrow file or with CLOTH, abrasive aluminum-oxide (fig. 222).

d. **Assembly.** Slide an insulation plate into position on each side of the switch body. Cover each of these with a side plate. Secure plates to body with round-head screw from untapped hole in one side plate to tapped hole in opposite plate.

124. LOAD SWITCH.

a. **Description.** The load switch, which controls the delivery of current to the power receptacles, is of the lever type. It is placed at the rear of the instrument panel with the switch lever projecting through to the front. When handle is in top position, the current is "ON." Bottom position is "OFF." Bolted to the back of the switch is a panel holding the three 200-amp fuses, three 30-amp fuses, and the two current transformers.

b. **Removal.**

(1) Take brass nuts from bottom of 200-amp fuse clips on the fuse panel, and remove leads.

(2) Take brass nuts from the three studs at the bottom of the fuse panel, and remove leads. Loosen screws at the top of the current transformers, and remove leads. Remove wood plugs and current transformers.

(3) Reach over the top of the front of the instrument panel and remove elastic stop nuts from six brass machine screws holding 30-amp fuse clips. Take off leads.

(4) Take four cap screws, washers, and nuts from each side of the fuse panel. Move panel and load switch out of position, turn sideways, and remove switch cover by taking out four machine screws.

(5) Take brass nut from top center stud on inside of switch, and remove load lead marked "B."

(6) Remove the brass nuts from the tops of the 200-amp fuse clips, and separate switch and fuse panel.

c. **Disassembly.** The switch should not be disassembled.

d. **Inspection and Repair.** This switch is not to be repaired. Mechanical troubles or any defects indicate the need for replacement.

e. **Installation.**

(1) Set fuse panel over back of switch with studs projecting through panel. Attach fuse panel to switch by screwing brass lock nuts on studs at the top of the three 200-amp fuse clips.

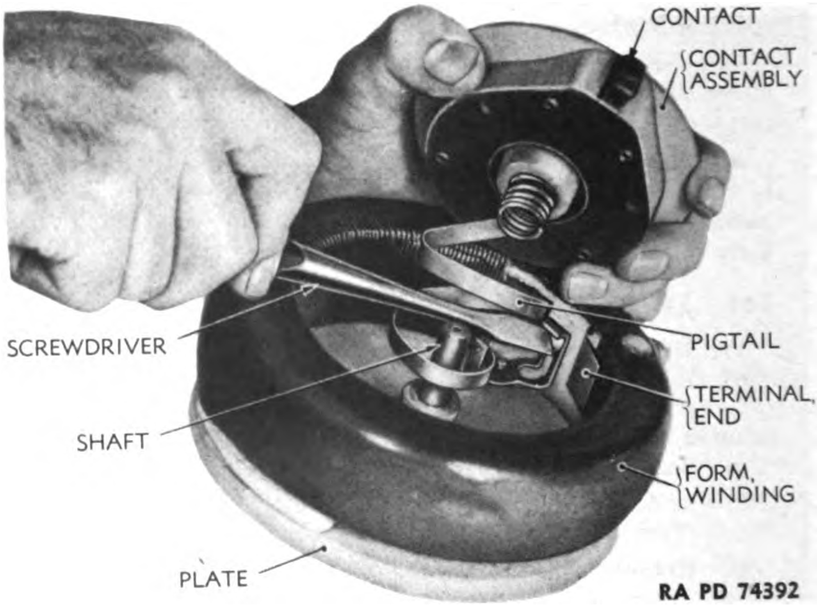


Figure 224 — Contact Assembly Removal

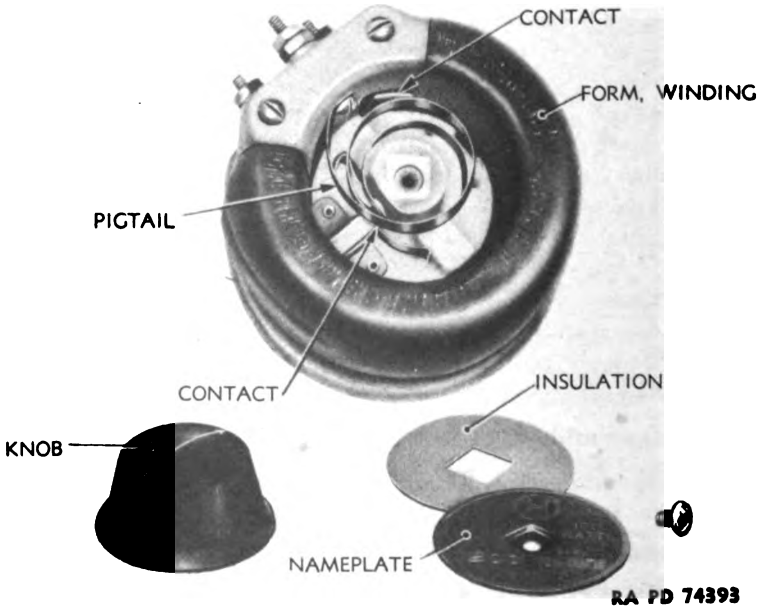


Figure 225 — Lamp-dimming Rheostat Disassembled

(2) Bring switch partly into position in back of instrument panel, and connect lead marked "B" to top center stud inside switch by installing brass nut.

(3) Place cover on switch, and secure by installing four screws through cover to switch.

(4) Bring switch into position at back of instrument panel, and install by connecting to brackets with four cap screws and nuts on each side of fuse panel.

(5) Reach over the top of the front of the instrument panel and attach leads to the 30-amp fuse clip bolts, securing the leads to the clip bolts with elastic stop nuts. To the first clip on the right attach lead marked "61." To the second clip, attach lead "CG." The third clip takes two leads, both marked "14." The fourth clip takes lead "A." To the fifth clip attach two leads marked "12," and to the last clip attach lead "C."

(6) On each of the two outside studs at the bottom of the fuse panel install a brass lock nut. On each stud place a current transformer, connection side up, secured in place with a wood plug. On top of each plug place a brass washer, and secure with another lock nut. To the left connector of each transformer attach a lead marked "3." To the right connector of the left-hand transformer attach lead "4." To the right connector of the right-hand transformer attach lead "8."

(7) On each of the three studs at the bottom of the fuse panel put a brass washer. To the left stud attach load leads marked "C," and secure with a plain brass washer, a star washer, and a brass lock nut. To the center cable attach load leads marked "B" over a brass washer, and follow with another brass washer, a star washer, and a brass lock nut. On the right-hand stud place a brass washer, attach load leads "A," and secure with another brass washer, a star washer, and a brass lock nut.

(8) To the bottom stud on the left-hand 200-amp fuse clip attach leads marked "T3." To the bottom stud on the center clip attach leads marked "T2." The third clip takes leads marked "T1." Secure each lead with two brass lock nuts.

125. FIELD RHEOSTAT.

a. Description. The field rheostat controls the output voltage of the unit. To increase the voltage of the current delivered, the knob is turned counterclockwise. The minimum voltage position is with the knob turned as far as possible clockwise. This is also starting and stopping position.

b. Removal.

(1) Disconnect leads from binding posts at rear of rheostat by removing nuts.

(2) Take out vertical screw holding rheostat knob to shaft, and remove knob.

(3) Take out two screws on the face of the instrument panel holding rheostat to panel. Remove rheostat.

c. **Disassembly.**

(1) Take out screw holding contact assembly to shaft (fig. 223).

(2) Lift up contact assembly, and remove screw attaching lug on end of pigtail to the winding form (fig. 224). Remove contact assembly and pigtail from the winding form.

d. **Inspection and Repair.** Check all parts for breaks or cracks. If winding form or contact case is cracked or broken, the rheostat must be replaced. Note the condition of windings, contacts, and pigtail. If they show signs of corrosion or are dirty, rub end terminal, contact, pigtail, and the exposed section of the windings with PAPER, flint, Class B, No. 2/0. The windings must be rubbed very lightly. Do not use CLOTH, abrasive, aluminum-oxide. When through, clean the rheostat carefully, and blow away all sand particles with compressed air.

e. **Assembly.**

(1) Bring contact assembly down into position over winding form, and attach lug at end of pigtail connection to winding form with round-head screw in side of winding form.

(2) Assemble contact assembly to shaft, and connect with round-head screw.

f. **Installation.**

(1) Attach rheostat tapped holes.

(2) Slip knob over rheostat shaft, and secure to shaft with vertical screw.

(3) Attach lead marked "A-1" to the left binding post of the rheostat, and secure with nut. Attach lead marked "F" to center post of rheostat, and install a wire jumper from center post to right pose. Secure with nuts. NOTE: This applies when rheostat terminals are up. Check wiring with figure.

126. LAMP-DIMMING RHEOSTAT.

a. **Description.** The lamp-dimming rheostat, used to dim the 125-volt lamps, is centrally located at the top of the instument panel.

b. **Removal.**

(1) Take off nuts from connections on rear of rheostat. Remove leads.

(2) Take out screw through rheostat knob, and slide knob off.

(3) Unscrew nut holding rheostat shaft sleeve against the face of the panel, and slide rheostat out at the back of the panel.

c. **Disassembly.** Take out fillister-head screw holding nameplate and insulation to shaft. Remove name plate and insulation (fig. 225).

d. **Inspection and Repair.** Check all parts for breaks or cracks. If winding form or porcelain center are broken, the rheostat must be replaced. Note the condition of windings, contacts, and pigtail. If they show signs of corrosion or are dirty, rub end terminal, contact, pigtail, and the exposed section of the windings with PAPER, flint, Class B, No. 2/0. The windings must be rubbed very lightly. Do not use CLOTH, abrasive, aluminum-oxide. When through, clean the rheostat carefully, and blow away all sand particles with compressed air.

e. **Assembly.** Place nameplate over the insulation ring, set in position on rheostat, and secure with fillister-head screw.

f. **Installation.**

(1) Install rheostat at back of panel with shaft projecting through panel. Secure in place with nut on shaft sleeve set tight against face of panel.

(2) Twist knob on shaft, and secure by tightening screw through knob against flatted part of shaft.

(3) Install two leads marked "16" to the left connection on the rheostat. Install lead marked "24" on the center post, and install a jumper from center post to right post. Secure with nuts. NOTE: This applies when rheostat terminals are up. Check wiring with figures 212 and 212 A.

127. THROTTLE CONTROL.

a. **Description.** The throttle knob is at the lower left in the control group on the left side of the instrument panel. This knob has a wire connection with a valve in the throttle body below the carburetor. Pulling out the knob reduces the amount of fuel mixture supplied the engine, and reduces engine speed.

b. **Removal.**

(1) Loosen clamping screws holding throttle wire and casing to carburetor, and remove wire. Loosen bolt through support bracket on top of engine, and remove wire from bracket.

(2) Unscrew nut from throttle knob casing on back of instrument panel, and remove nut. Remove knob, casing, and wire from the front of the instrument panel.

c. **Inspection and Repair.** The throttle control cannot be repaired, and if faulty, must be replaced.

d. Installation.

(1) Insert throttle wire and casing through instrument panel hole until rim of knob casing holds against front of panel. Carry nut over wire and screw on to threaded section of knob casing until the assembly is held securely in place.

(2) Fasten wire through support bracket on engine. Hold throttle lever on carburetor forward, bring wire through lever clamp, and tighten clamp.

128. CHOKE CONTROL.

a. Description. The choke knob is at the lower right in the control group on the left side of the instrument panel. This knob has a wire connection to a valve in the carburetor that regulates the carburetor air supply. Pulling out the knob cuts down on the air from into the carburetor.

b. Removal.

(1) Loosen clamping screws holding choke wire and casing to carburetor valve arm, and remove wire. Loosen bolt through support bracket on top of engine, and remove wire from bracket.

(2) Unscrew nut from choke knob casing on back of instrument panel, and remove nut. Remove knob, casing and wire from the front of the instrument panel.

c. Inspection and Repair. The choke control cannot be repaired, and if faulty, must be replaced.

d. Installation.

(1) Insert choke wire and casing through instrument panel hole until rim of knob casing holds against front of panel. Carry nut over wire, and screw on to threaded section of knob casing until the assembly is held securely in place.

(2) Fasten wire through support bracket on engine. Bring wire to carburetor, hold lever arm forward, and clamp wire to binding post on arm.

129. 125-VOLT LIGHT RECEPTACLES.

a. Description. At the top of the instrument panel are two 125-volt rubber-mounted light receptacles. They are controlled by the 125-volt light switch in the center of the panel, and the amount of the illumination given is regulated by the lamp-dimming rheostat set between them.

b. Removal.

(1) Trace lead "16" to lamp-dimming rheostat, remove nut, and remove lead. Trace lead "23" to 125-volt light switch, remove screw and lead.

(2) Hold screws, remove nuts at back of instrument panel, and remove receptacle.

c. **Inspection and Repair.** If inspection shows these receptacles to be damaged, they cannot be repaired, and must be replaced.

d. **Installation.**

(1) Bring receptacle to mounting holes in the front of the panel. Install with bolts through receptacle and panel with nuts at rear of panel.

(2) Connect receptacle lead "16" to the left connection of the lamp-dimming rheostat. Secure with nut. Connect receptacle lead "23" to the top left connection of the 125-volt light switch. Secure leads with screws.

130. 6-VOLT LIGHT RECEPTACLES.

a. **Description.** A 6-volt light receptacle is located at the top of the instrument panel for use in illuminating the panel at times when the unit is not being operated and the 125-volt circuit cannot be used. This light is controlled by the toggle switch at the upper right in the control group above the starter button.

b. **Removal.**

(1) Loosen horizontal screw through the body of the receptacle, and remove lead from center of back.

(2) Unscrew nut from the receptacle ring, and remove receptacle.

c. **Inspection and Repair.** If inspection shows this receptacle to be damaged, it cannot be repaired, and must be replaced.

d. **Installation.**

(1) Insert receptacle through panel until rim holds it in place. Install nut on back of receptacle.

(2) Insert lead wire "62" into connection hole at back of receptacle. Secure wire in place by tightening horizontal screw through body of receptacle.

131. 6-VOLT EXTENSION CORD RECEPTACLE.

a. **Description.** A receptacle to take the 6-volt trouble light carried in the tool box is provided at top center in the control group above the starter button.

b. **Removal.**

(1) Loosen horizontal screw through the body of the receptacle, and remove lead from center of back.

(2) Unscrew nut from the receptacle ring, remove receptacle.

c. **Inspection and Repair.** If inspection shows this receptacle to be damaged, it must be replaced.

d. Installation.

(1) Insert receptacle through panel until rim holds it in place. Install nut on back of receptacle.

(2) Insert lead wire "61" into connection hole at back of receptacle. Secure wire in place by tightening horizontal screw through body of receptacle.

132. T-SLOT RECEPTACLES.

a. Description. One T-slot receptacle of the regular base receptacle type is provided on the instrument panel, and four on the apron below. The one on the panel is intended for use with 125-volt trouble light carried in the tool box. The receptacles on the apron are for electric tools.

b. Removal.

(1) Unscrew connector screws at back of receptacle, and take off leads.

(2) Take out the two screws holding the receptacle to the panel, and remove receptacle.

c. Inspection and Repair. If inspection shows a receptacle to be damaged, it cannot be repaired, and must be replaced.

d. Installation.

(1) Insert receptacle through hole from rear of instrument panel, alining tapped mounting holes in receptacle with mounting holes in panel. Secure receptacle to panel with screws through panel and receptacle.

(2) Attach lead marked "14" to one receptacle connection, lead marked "12" to the other. Secure with screws.

(3) Attach two leads marked "14" to one connection, one lead marked "9" to the other connection. Secure with screws. The end receptacle of the series will take only one "14" lead.

133. TERMINAL BLOCK.

a. Description. An eight-position terminal block in back of the instrument panel handles connections for both 6-volt and 125-volt circuits. A center label plate identifies the connection. The third and the eighth positions are unused. The block is mounted on arms welded to the load switch bracket.

b. Removal.

(1) Loosen screw connectors, and remove leads.

(2) Hold round-head screw at top left, remove nut at rear. Hold round-head screw at lower right, remove nut at rear, and remove block.

c. **Inspection and Repair.** If the block is cracked or broken, it cannot be repaired, and must be replaced.

d. **Installation.**

(1) Install block with round-head screws and nuts.

(2) Attach leads under the connection screws, marked identically with the labels on the wires.

134. FUSE BLOCKS.

a. **Description.** Two double fuse blocks are located on the under side of the instrument panel bottom ledge. These fuse blocks hold four 30-amp fuses connected with the four T-slot receptacles on the instrument panel apron.

b. **Removal.**

(1) Take out screw connectors, and take off leads. Remove fuses.

(2) Hold screw heads, and remove nuts. Remove fuse block.

c. **Inspection and Repair.** If blocks are cracked or broken, they cannot be repaired and should be replaced.

d. **Installation.**

(1) Attach fuse block to panel with round-head screws and nuts.

(2) To the connections nearest the T-slot receptacles, connect receptacle leads, one lead for each fuse. To one connection on the opposite end, connect lead "A" for one block, lead "B" for the other. In each fuse block, bridge this connection to the adjoining connection with a short wire.

CHAPTER 6

MISCELLANEOUS

Section I

LUBRICATION INSTRUCTIONS

135. INTRODUCTION.

a. Lubrication is an essential part of preventive maintenance, determining to a great extent the serviceability of parts and assemblies. Materiel must be lubricated in accordance with the latest instructions contained in Technical Manuals and Ordnance Field Service Bulletins. Lubricating fittings are identified by a red circle, ¾ inch in diameter.

136. LUBRICATION GUIDE.

a. General. Lubrication instructions for this material are consolidated in a Lubrication Guide (fig. 226). These specify the points to be lubricated, the periods of lubrication, and the lubricant to be used. NOTE: The Lubrication Guide and notes set forth below cover both the Generating Unit M7 and Generator Trailer M7. They agree with the Lubrication Guide packed with the materiel which at the present time covers both of these items in one guide. Lubrication and maintenance of the Generator Trailer M7 is covered in TM 9-881.

b. Notes. The following notes apply to the Lubrication Guide (fig. 226.). Any note reference in the Lubrication Guide itself is to the subparagraph below having the corresponding number. For lubrication and service below zero F, refer to OFSB 6-5.

(1) FITTINGS. Clean before applying lubricant. Lubricate until new lubricant is forced from the bearing, unless otherwise specified. CAUTION: Lubricate trailer points after washing.

(2) INTERVALS. Those indicated are for normal service. For extreme conditions of speed, heat, water, sand, mud, snow, rough roads, dust, etc., reduce interval on guide by one-third or one-half or more if conditions warrant.

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(3) CLEANING. SOLVENT, dry-cleaning, or OIL, fuel Diesel, will be used to clean or wash all parts. Use of gasoline for this purpose is prohibited. All parts will be thoroughly dry before relubrication.

(4) AIR CLEANER. Daily, check level and refill oil reservoir to bead level with used crankcase oil or OIL, engine, SAE 30 above + 32 F and SAE 10 + 32 F to zero F. Below zero F, remove oil, and operate dry. Every 150 hours, or daily, if operating in extreme dust conditions, remove entire assembly. Clean entire air cleaner and air pipes. Proper maintenance of air cleaners is essential to prolonged engine life.

(5) CRANKCASE. Drain only when engine is hot. Every 50 hours, drain, and refill to "FULL" mark on gage. Run engine a few minutes, and recheck oil level.

CAUTION: Be sure pressure gage indicates oil is circulating.

(6) OIL FILTER. Before draining crankcase oil, remove plug on filter which covers the oil reversing valve and, with the engine running, drain 2 quarts of oil. Stop engine and drain crankcase. After draining, remove filter shell, and scrape sludge from filter felts. Clean filter shell, and reassemble. Refill crankcase to "FULL" mark on gage. Run engine a few minutes, recheck level, and add oil to "FULL" mark.

(7) FAN. If grease-lubricated, remove plug and insert fitting to lubricate fan bearings. Replace plug. If oil-lubricated, use hand oiler.

(8) DISTRIBUTOR. Every 200 hours, wipe distributor breaker cam lightly with GREASE, general purpose, No. 1 above +32 F or No. 0 below +32 F; lubricate breaker arm pivot, wick under rotor, and governor weight pivots and slots, with 1 to 2 drops of OIL, engine, SAE 30 above +32 F; SAE 10 +32 F to zero F, and OIL, lubricating, preservative, light, below zero F.

(9) BRAKE CABLES. Every 6,000 miles, remove inner cables, clean and coat lightly with GREASE, general purpose, No. 0. Do not fill housings.

(10) WHEEL BEARINGS. Remove bearing cone assemblies from hub, and wash spindle and inside of hub. Inspect bearing races, and replace, if necessary. Wet the spindle and inside of hub and hub cap with wheel bearing grease to a maximum thickness of 1/16 inch. only to retard rust. Wash bearing cones and grease seals. Inspect, and replace, if necessary. Lubricate bearings with wheel bearing grease with a packer or by hand, kneading lubricant into all spaces in the bearing. Use extreme care to protect bearings from dirt, and immediately reassemble, and replace wheel. The lubricant in the bearings is sufficient to provide lubrication until the next service period. Any excess might result in leakage into the brake drum.

(11) OILCAN POINTS. Every 50 hours or 1,000 miles, lubricate caster hanger bearing, water pump drive chain, hand brake ratchet,

KEY

LUBRICANTS

OE—OIL, engine
Except crankcase
SAE 30 (above +32°F.)
SAE 10 (+32°F. to 0°F.)
PL (below 0°F.)

CG—GREASE, general purpose
No. 1 (above +32°F.)
No. 0 (below +32°F.)

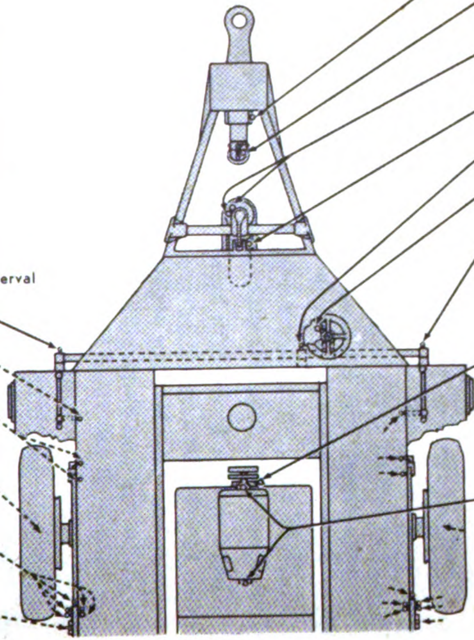
WB—GREASE, general purpose, No. 2

WP—GREASE, water pump

GL—GREASE, lubricating, special

PL—OIL, lubricating, preservative, light

CAUTION—Lubricate Dotted Arrow Points on ***Both Sides***. Points on ***Opposite Side*** are indicated by Dotted Short-Shaft Arrows.



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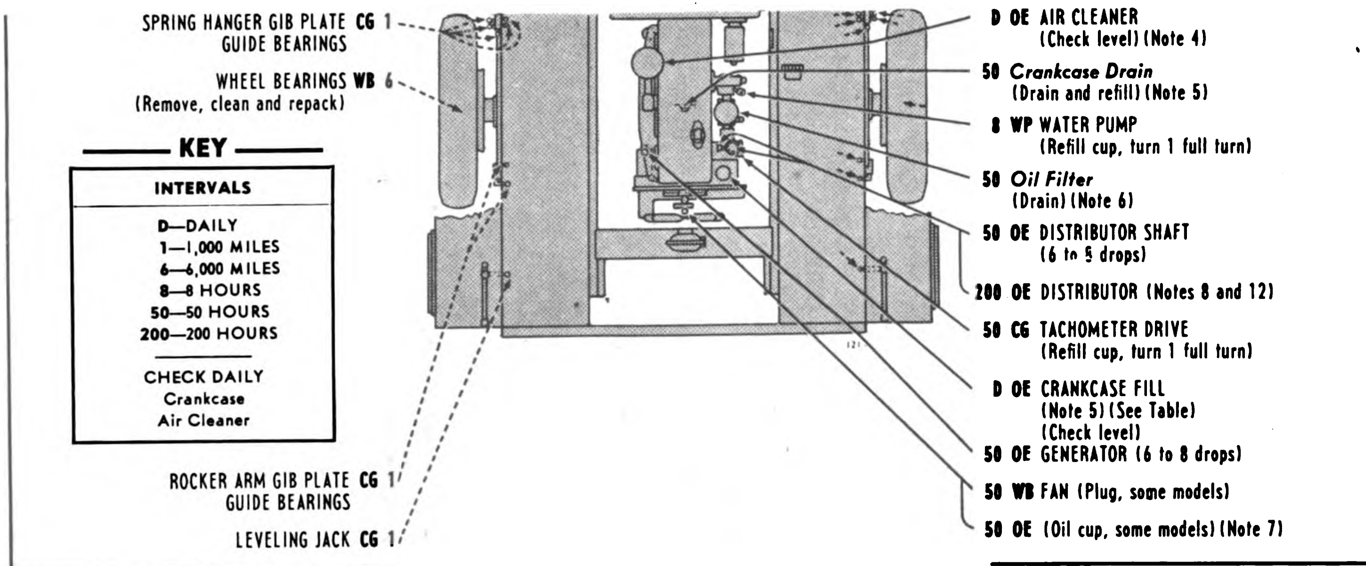

TABLE OF CAPACITIES AND LUBRICANTS TO BE USED

UNIT	CAPACITY (Approx.)	LOWEST EXPECTED AIR TEMPERATURE		
		+32° F. and above	+32° F. to 0° F.	Below 0° F.
Crankcase	7 qt.	OE SAE 30	OE SAE 10	Refer to OFSB 6-5

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Figure 226 — Lubrication Guide

linkage, tail gate hinges, hood hinges, and latches with OIL, engine, SAE 30 above +32 F; SAE 10 +32 F to zero F and OIL, lubricating, preservative, light, below zero F.

(12) POINTS TO BE SERVICED AND/OR LUBRICATED BY ORDNANCE MAINTENANCE PERSONNEL. Generator and exciter shaft bearings, starter, distributor (disassembly only) (par. 137).

(13) POINTS REQUIRING NO LUBRICATION SERVICE. Springs, governor, flexible coupling.

137. POINTS TO BE SERVICED AND/OR LUBRICATED BY ORDNANCE MAINTENANCE PERSONNEL.

a. **Generator and Exciter Shaft Bearings.** Yearly, or whenever the generator and/or exciter is disassembled, remove, clean, and repack the bearings with GREASE, lubricating, special.

b. **Starter.** Whenever starter is disassembled, clean, and coat bearings and seats with OIL, engine, SAE 10.

c. **Distributor.** Whenever distributor is disassembled, pack pockets in governor laminated weights with GREASE, general purpose, No. 1, above +32 F, and No. 0 below +32 F.

138. REPORTS AND RECORDS.

a. **Reports.** If lubrication instructions are closely followed, proper lubricants used, and satisfactory results are not obtained, a report will be made to the ordnance officer responsible for the maintenance of the materiel.

b. **Records.** A complete record of seasonal changes of lubricants will be kept in the Artillery Gun Book for the materiel.

Section II

CONSOLIDATED SERVICE DATA

139. FITS AND CLEARANCES.

a. **Clearances.**

	Minimum	Maximum
Valve tappet clearance, intake	0.006 (engine hot)	—
Valve tappet clearance, exhaust	0.010 (engine hot)	—
Valve seat face width, intake and exhaust	1/8 in.	5/32 in.
Valve seat diameter, intake	1 13/16 in.	—

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Clearances (cont'd)	Minimum	Maximum
Valve seat diameter, exhaust	$1\frac{11}{16}$ in.	—
Valve stem clearance in guide, standard exhaust and intake	0.001	0.0015
Valve tappet clearance in guide	0.00075	0.001
Idler bearing clearance	0.001	0.0015
Cam bearing clearance	0.0015	0.0025
Crankshaft main bearing clearance	0.002	0.003
Bellhousing on chamfer	0.012	0.025
Connecting rod bearing	0.0015	0.002
Accessory or water pump drive shaft	0.0015	0.0025
Gear cover clearance around water pump shaft	0.006	0.015
Gear cover clearance around crankshaft	0.008	0.015
Oil pan clearance around crankshaft	0.008	0.015
Piston pin clearance	0.0002	0.0003
Piston ring to land clearance	0.0015	0.003

b. Gear Backlash.

Accessory gear to idler	0.002	0.004
Idler gear to cam gear	0.001	0.002
Camshaft gear to crank gear	0.000	0.001
Oil pump gear to cam gear	0.008	0.010

c. Gap Settings.

Piston ring gap	0.015	0.020
Spark plug electrodes	0.024	0.028
Distributor breaker points	0.019	0.021

d. End Thrust.

Crankshaft end thrust	0.003	0.005
Connecting rod end clearance	0.005	0.010
Accessory shaft end clearance	0.001	0.003

e. Spring Tensions.

Exciter brushes	12 oz	14 oz
Alternator	8 oz	—

140. WRENCH TENSIONS.

	Foot Pounds	Inch Pounds
Cylinder head screws (when using copper asbestos cylinder head gasket)	60	720
Cylinder head screws (when using steel asbestos cylinder head gasket)	75	900
Connecting rod nuts	63	756
Main bearings, center and rear	70	840
Main bearings, front and inter.	105	1,260

Section III

REFERENCES

141. STANDARD NOMENCLATURE LISTS.

a. Unit, generating, M7 .... SNL F-226

b. Cleaning, preserving and lubricating materials; recoil fluids, special oils, and miscellaneous related items .... SNL K-1

c. Major items of antiaircraft artillery .... SNL D-2

d. Railway and antiaircraft artillery sighting equipment and fire control instruments .... SNL F-2

e. System, cable, M3 .... SNL F-244

Current standard nomenclature lists are as tabulated here, An up-to-date list of SNL's is mainmained as the "Ordnance Publications for Supply Index," now published in .... OFSB 1-1

142. EXPLANATORY PUBLICATIONS.

a. **Fire Control.**

Instruction guide: Director M7 .... TM 9-2658

Instruction guide: The instrument repairman .... TM 9-2602

Instruction Guide: Height finder M1 .... TM 9-2623

Ordnance maintenance: Director M7 .... TM 9-1658

Ordnance maintenance: Height finder M1 .... TM 9-1623

Ordnance maintenance: Remote control systems M2 .... TM 9-1642

b. **Gun Materiel.**

90-mm antiaircraft gun materiel M1 and M1A1 .... TM 9-370

90-mm gun M1 and 90-mm antiaircraft gun mount T2E1 .... TM 9-371

c. Automotive Materiel.

Automotive electricity	TM 10-580
Automotive lubrication	TM 10-540
Chassis, body, and trailer units	TM 10-560
Fuels and carburetion	TM 10-550
Generating unit M7	TM 9-618
Generator trailer M7 (to be superseded by TM 9-1881, when published)	TM 9-881
Military motor transportation	TM 10-505
Motor transport	FM 25-10
Motor transport inspection	TM 10-545
Motor vehicles	AR 850-15
Ordnance storage and shipment chart-group F	OSSC-F
Sheet metal work, body, finder, and radiator repairs	TM 10-450
Storage of motor vehicle equipment	AR 850-18
The blacksmith and the welder	TM 10-440
The internal combustion engine	TM 10-570
The machinist	TM 10-445

d. Maintenance.

Cleaning, preserving, lubricating, and welding materials and similar items issued by Ordnance Department	TM 9-850
Detailed lubrication instructions for ordnance personnel	OFSB 6 series

e. Miscellaneous.

Chemical decontamination materials and equipment	TM 3-220
Defense against chemical attack	FM 21-40
Hand, measuring, and power tools	TM 10-590
Instruction guide: Welding—theory and application	TM 9-2852
List of publications for training	FM 21-6

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PUBLICATIONS DEPARTMENT — RARITAN ARSENAL

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